AD-A068 591 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. FURNACE BROOK W. S. DAM NUMBER 2 (--ETC(U)
APR 79 D J LEARY DACW61-78-C-0124

UNCLASSIFIED NL

1 OF 2
AD
A068 591

LEVEL II

DELAWARE RIVER BASIN
FURNACE BROOK
WARREN COUNTY
NEW JERSEY

FURNACE BROOK W.S.
DAM NO. 2
NJ 00137

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

April, 1979

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00137
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): Phase I Inspection Report
National Dam Safety Program
Furnace Brook W.S. Dam No. 2
Warren County, N.J.

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept.
6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): (10) Dennis J. Leary P.E.

8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-78-C-0124

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Langan Engineering Assoc. Inc.
970 Clifton Ave.
Clifton, N.J. 07013

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (12) 134p

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, Philadelphia
Custom House, 2d & Chestnut Streets
Philadelphia, Pennsylvania 19106

12. REPORT DATE: (11) Apr[illegible]979
13. NUMBER OF PAGES: 125

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Furnace Brook W. S. Dam Number 2 (NJ-00137), Delaware River Basin, Furnace Brook, Warren County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	Spillway
Riprap	Structural Analysis
Embankments	Visual Inspection
Furnace Brook W.S. Dam	National Dam Safety Act report

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

410 891

JOB

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

4 MAY 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Furnace Brook W.S. Dam No. 2 in Warren County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Furnace Brook W.S. Dam No. 2 a high hazard potential structure, is judged to be in fair overall condition and the spillway is considered adequate. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, the following remedial actions should be completed:

(1) Place riprap protection at the left portion of the dam along Buckley Avenue and if necessary, at the sides of the auxiliary spillway.

(2) Repair erosion on the downstream slope and along the spillway discharge channel.

(3) Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment.

(4) Provide a permanent walkway from the embankment to the top of the principal spillway riser to permit access to the spillway gate operators.

(5) Remove wood lodged in the sluice gate on the left side of the spillway.

b. Within one year from the date of approval of this report, the

NAPEN-D
Honorable Brendan T. Byrne

following remedial actions should be completed:

(1) Sags and ruts in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam.

(2) Repair erosion and remove the boulder at the spillway discharge impact basin.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

FURNACE BROOK W.S. DAM NO. 2 (NJ00137)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 14 December 1978 and 10 January 1979 by Langan Engineering Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, P.L. 92-367.

Furnace Brook W.S. Dam No. 2 a high hazard potential structure, is judged to be in fair overall condition and the spillway is considered adequate. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, the following remedial actions should be completed:

(1) Place riprap protection at the left portion of the dam along Buckley Avenue and if necessary, at the sides of the auxiliary spillway.

(2) Repair erosion on the downstream slope and along the spillway discharge channel.

(3) Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment.

(4) Provide a permanent walkway from the embankment to the top of the principal spillway riser to permit access to the spillway gate operators.

(5) Remove wood lodged in the sluice gate on the left side of the spillway.

b. Within one year from the date of approval of this report, the following remedial actions should be completed:

(1) Sags and ruts in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam.

(2) Repair erosion and remove the boulder at the spillway discharge impact basin.

APPROVED: _____
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 4 May 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	FURNACE BROOK W.S. DAM #2
ID NUMBER:	FED ID No NJ00137
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	WARREN
STREAM:	FURNACE BROOK TRIBUTARY TO
RIVER BASIN:	DELAWARE
DATE OF INSPECTION:	DECEMBER 1978

ASSESSMENT OF GENERAL CONDITIONS

Furnace Brook W.S. Dam #2 is 8 years old and in fair overall conditions. There are animal burrows in the downstream slope. Riprap has deteriorated or was not placed during construction in the areas of the auxiliary spillway side slopes and at the left portion of the dam along Buckley Avenue. The crest of the dam has vehicular ruts and sag ponds. The dam can adequately pass the PMF.

We recommend riprap protection be placed at the left portion of the dam along Buckley Avenue and if necessary, at the sides of the auxiliary spillway. This should be done soon. The erosion on the downstream slope and along the spillway discharge channel should be repaired. This should be done soon. Animal burrows in the downstream face of the dam should be completely plugged and protection provided against future animal burrowing into the embankment. This should be done soon. A permanent walkway from embankment to top of the principal spillway riser should be provided to permit access to spillway gate operators. This should be done soon. Wood lodged in the sluice gate on the left side of the spillway should be removed. This should be done soon. Sags and ruts in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam. This should be done in the near future. The erosion should be repaired and the boulder at the spillway discharge impact basin should be removed. This should be done in the future.

Dennis J. Leary, P.E.

OVERVIEW

FURNACE BROOK W.S. DAM #2

1 DECEMBER 1978

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	FURNACE BROOK W.S. DAM #2
ID NUMBER:	FED ID No NJ00137
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	WARREN
STREAM:	FURNACE BROOK TRIBUTARY TO
RIVER BASIN:	DELAWARE
DATE OF INSPECTION:	DECEMBER 1978

LANGAN ENGINEERING ASSOCIATES, INC.

Consulting Civil Engineers
990 CLIFTON AVENUE
CLIFTON, NEW JERSEY

CONTENTS

NATIONAL DAM SAFETY REPORT

FURNACE BROOK W.S. DAM #2 FED ID NO NJ00137

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SECTION 1 PROJECT INFORMATION

1.1 General

Authority to perform the Phase I Safety Inspection of Furnace Brook W.S. Dam #2 was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 20 November 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the US Army Engineers District, Philadelphia.

The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Furnace Brook W.S. Dam #2 and appurtenances based upon available data and visual inspection, and, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted. The assessment is made using screening criteria established in Recommended Guidelines for Safety Inspection of Dams prepared by the Department of Army, Office of the Chief of Engineers. It is not the purpose of the inspection report to imply that a dam meeting or failing to meet the screening criteria, is per se, certainly adequate or inadequate.

1.2 Project Description

Furnace Brook W.S. Dam #2 is an 8 year old, 55-ft high, 1680-ft long earthfill dam. It has 3 hor to 1 vert upstream and downstream slopes. The upstream slope is riprapped and the downstream slope is grassed. There is a one to eighteen foot deep cutoff trench along the centerline of the dam and a vertical sand drain below the downstream slope. The dam has a principle spillway at its center and an auxiliary spillway at the right abutment. The principle spillway is a drop inlet structure consisting of a two stage reinforced concrete upstream riser, a 30-in-dia RC water pipe under the dam, and a RC impact basin at the downstream toe. There are three partially screened relief wells and two observation wells in the area of the impact basin. The auxiliary spillway is a 500-ft-wide grassed open channel. It has a negatively sloped entrance, a 50-ft-level reach, a control section, and a positively sloped outlet.

The dam is located in Warren County, New Jersey approximately one mile upstream from Oxford on Furnace Brook. It is at north latitude 40° 47.9' and west longitude 75° 0.8'. A regional vicinity map is given in Fig 1 and essential features of the dam are given in Fig 2.

Furnace Brook W.S. Dam #2 is classified as being "Intermediate" on the basis of its maximum reservoir storage volume of 1440 ac-ft which is less than 50,000 ac-ft, but more than 1000 ac-ft. It is classified as "Intermediate" on the basis of its total height of 55 ft which is more than 40 feet, but less than 100 feet. The dam is therefore, classified as "Intermediate" in size.

In the National Inventory of Dams, Furnace Brook W.S. #2 has been classified as having "High Hazard Potential" on the basis that failure of the dam would cause excessive property damage to residences downstream, and could potentially cause more than a few deaths. Visual inspection of the downstream area shows that breach of the dam could cause damage to residences and be hazardous to people utilizing Buckley Road. Accordingly, It is proposed not to change the Hazard Classification Potential.

The dam is owned by Oxford Township, Warren County, New Jersey.

The purposes of the dam are flood control and recreation.

The dam was designed by the U.S. Department of Agriculture, Soil Conservation Service, 1370 Hamilton Street, P.O. Box 219, Somerset, New Jersey 00873. The principal designer is Mr. C.J. Montana.

1.3 Pertinent Data

a. Drainage Area is 2.87 sq mi

Normal water surface area is 53 acres

b. Discharge at Dam Site

Maximum known flood at dam site:	Unknown
Principal spillway capacity at flood pool elevation:	137 cfs
Principal spillway capacity at maximum pool elevation:	Approx. 140 cfs
Auxiliary spillway capacity at maximum pool elevation:	Approx 14,360 cfs
Total spillway capacity at maximum pool elevation:	Approx 14,500 cfs

c. Elevation (ft above MSL)

Top Dam:	El. 591.60 (low point) El. 593.0 (center of embankment)
Design high water:	El. 588.60
Full flood control pool:	El. 586.9
Recreation pool:	El. 579.00
Spillway crest:	Principal @ El. 581.16, Auxiliary @ El. 586.9

	Streambed at centerline of dam:	D/S @ El. 538, U/S El. 543.5
	Maximum tailwater:	Approx. 538.5 at time of inspection
d.	Reservoir	
	Length of maximum pool:	3200 ft
	Length of recreation pool:	2550 ft
	Length of flood control pool:	3000 ft
e.	Storage (acre-feet)	
	Recreation pool:	640 AF
	Flood control pool:	1120 AF
	Design high water :	1240 AF
	Top of dam:	1440 AF
f.	Reservoir Surface (acres)	
	Top dam:	75.5 Ac.
	Design high water pool:	72.0 Ac.
	Flood-control pool:	68 Ac.
	Recreation pool:	53 Ac.
	Auxiliary spillway crest:	68 Ac.
g.	Dam	
	Type:	Earthfill
	Length:	1680 ft
	Height:	55 ft (Maximum)
	Top width:	18 ft $\pm$
	Side slopes:	U/S and D/S 3 hor: 1 vert
	Zoning:	None observed

	Impervious core:	None observed
	Cutoff:	Cutoff trench along centerline
	Grout Curtain:	None observed
h.	Spillway	
	Type:	Drop inlet consisting of two stage riser
	Length of weir:	15 ft effective
	Crest elevation:	El. 581.16
	Invert of low stage orifice:	El. 578.91
	Gates:	None observed
	U/S channel:	None observed
	D/S channel:	None observed
i.	Auxiliary Spillway	
	Type:	Grassed open channel with a negatively sloped entrance, a 50-ft level reached a positively sloped outlet.
	Length of reach:	500 feet
	Crest elevation:	El. 586.9
j.	Regulating Outlets	18-in-dia gate opening at base of dam and drop inlet spillway leading to 30-in-dia RC pipe. Gate operator and spillway located at approximately middle of dam and upstream slope.

SECTION 2 ENGINEERING DATA

2.1 Design

Furnace Brook W.S. Dam #2 was designed as a multi-purpose dam by the U.S. Department of Agriculture Soil Conservation Service between 1968 and 1970. Available documents include a relatively comprehensive record of the results of field and laboratory investigations, design calculations, and conclusions. A summary of the Engineering Data is given in Appendix 1.

2.2 Construction

The dam was constructed by K.P. & B. Construction Company of Belvidere, N.J. between September 1970 and December 1971. Our review of the construction records indicate the principal dam designer visited the work about once a month, problems encountered during construction were resolved, and Mr. Robert L. Hardman, acting Chief Engineer, N.J. DEP Div. of Water Resources, certified the dam was built according to plans and specifications.

2.3 Operation

Operation of the dam is the responsibility of the Township of Oxford, New Jersey under agreement with the Soil Conservation Service. A copy of this agreement is included in Appendix 1.

2.4 Evaluation

The availability, adequacy and validity of the information concerning the design and construction of the dam are satisfactory.

SECTION 3 VISUAL INSPECTION

Our visual inspection of Furnace Brook W.S. Dam #2 was made in the company of Messrs. L. Holt, D. Smart, and B. Irwin of the Soil Conservation Service and Mr. Coppersmith of C. Douglas Cherry & Assoc., Engineers for the Township of Oxford.

There is no riprap on the side slopes of the auxiliary spillway. Rutting and sag ponds have occurred along the crest of the dam. Riprap has deteriorated or was not completed along the left upstream portion of the dam along Buckley Avenue. There are animal burrow holes in the downstream slope and drainage ruts along the downstream toe of the dam. There is approx. 1.5 ft deep erosion and a large boulder against the left side of the concrete of the impact basin. Access of the top of the spillway riser is by way of a wooden plank from the embankment. There is a piece of wood in the gate at the left side of the spillway. The slopes of the spillway discharge channel has eroded 1 to 2 ft at two locations.

SECTION 4 OPERATIONAL PROCEDURES

Operational procedures have been established by the Soil Conservation Service and the Township of Oxford is responsible for following these procedures. The operation and maintenance agreement between the SCS and the Township is given in Appendix 1.

SECTION 5 HYDRAULICS/HYDROLOGIC

Based on a review on the hydrologic design data supplied by the U.S. Department of Agriculture, Soil Conservation Service, the dam has been designed in accordance with present day criteria and is considered satisfactory.

The dam has been designed on the basis of a PMF Detention from the freeboard hydrograph rainfall from National Engineering Handbook, Section 4, ES 1020 Sh. 5 of 5. This flood is equivalent to 25.3 inches of rainfall and has a peak inflow of 15888 cfs.

The total capacity of the spillway at maximum pool is 14,500 cfs which is slightly less than SDF.

Flood routing for the PMF (done by the SCS) indicates the dam will not overtop. The dam can adequately pass the PMF with a routed peak outflow of 14363 cfs.

Design drawdown calculations showed that more than 80% of the flood storage can be removed within 10 days. Our calculations indicate the lake level could be lowered 19 ft from normal pool in approximately 9 days.

SECTION 6 STRUCTURAL STABILITY

Based upon our visual observations and review of the design and construction data, it is our opinion Furnace Brook W.S. Dam #2 is structurally stable under static loading. Calculated minimum factors of safety of upstream slope under drawdown condition and of downstream slope under steady seepage condition are reported to be 1.44 and 1.83 respectively. These analyses were made using the Swedish circle method and the results are considered conservative.

There are no available operating records. Past construction changes consisted of repairs to correct elongation of the 30-in-dia principal spillway pipe below the dam, and, repair of erosion of the toe of the eastern embankment and improvements of the gutter on the downstream slope of the dam.

Furnace Brook W.S. Dam #2 is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States. The degree of stability of the dam and appurtenances are assumed to be within conventional safety margins and to present no hazard from earthquakes. If, however, the Seismic Zone rating is seriously increased in the future, or data becomes available to indicate it may be increased, further study with respect to seismic stability may be necessary.

SECTION 7 ASSESSMENT, RECOMMENDATION/REMEDIAL MEASURES

7.1 Assessment

Furnace brook W.S. Dam#2 is 8 years old and in fair overall condition. There are animal burrows in the downstream slope. Riprap has deteriorated or was not placed during construction in the areas of the auxiliary spillway side slopes and at the left portion of the dam along Buckley Avenue. The crest of the dam has vehicular ruts and sag ponds. The dam can adequately pass the PMF.

7.2 Recommendations/Remedial Measures

We recommend the following remedial measures:

1. Place riprap protection at the left portion of the dam along Buckley Avenue and if necessary, at the sides of the auxiliary spillway. This should be done soon.

2. Repair erosion on downstream slope and along spillway discharge channel. This should be done soon.

3. Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment. This should be done soon.

4. Provide a permanent walkway from embankment to top of principal spillway riser to permit access to spillway gate operators. This should be done soon.

5. Remove wood lodged in sluice gate on left side of spillway. This should be done soon.

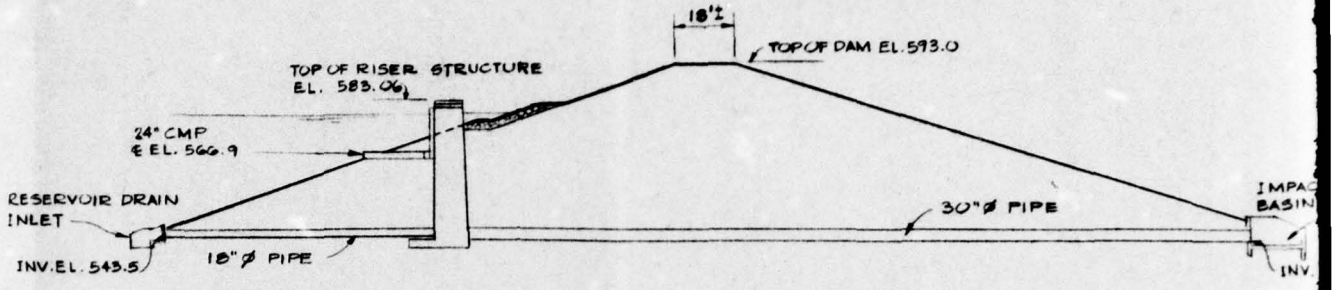
6. Sags and ruts in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam. This should be done in the near future.

7. Repair erosion and remove boulder at the spillway discharge impact basin. This should be done in the future.

1 in ≈ 5.2 mi

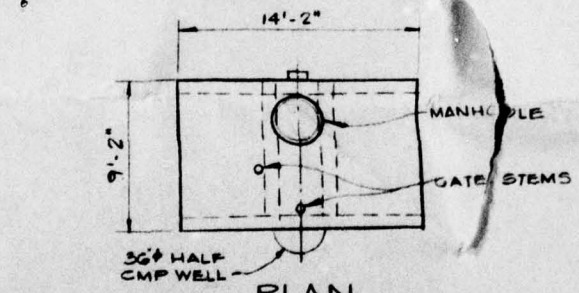
REGIONAL VICINITY MAP
FURNACE BROOK W.S. DAM #2

Fig. 1

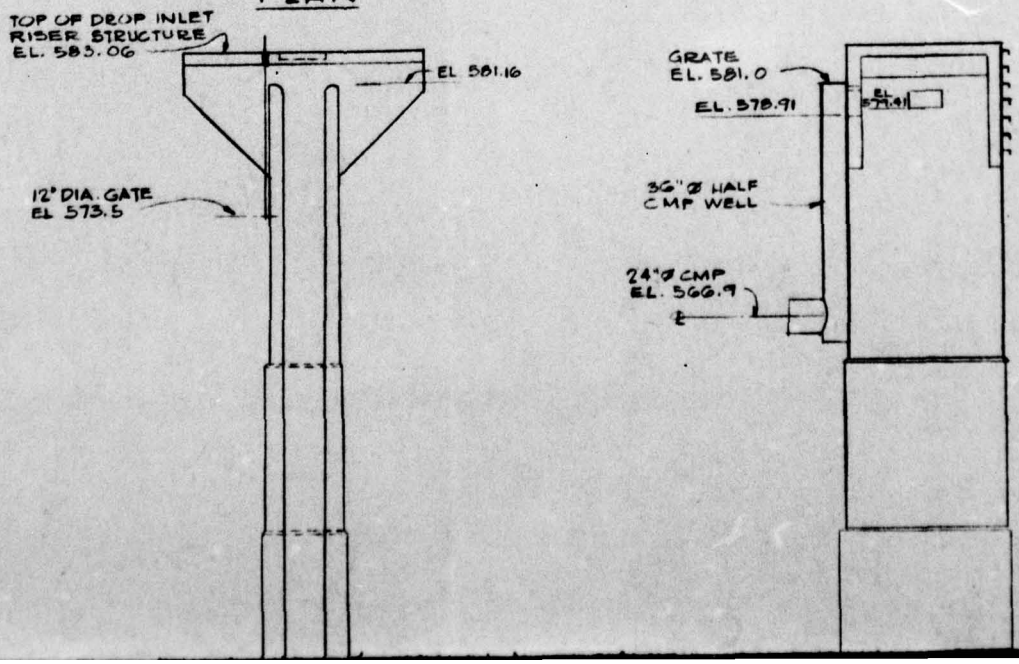


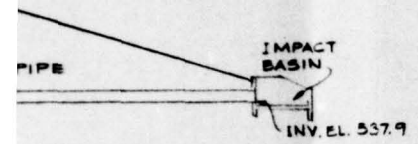
SECTION A-A

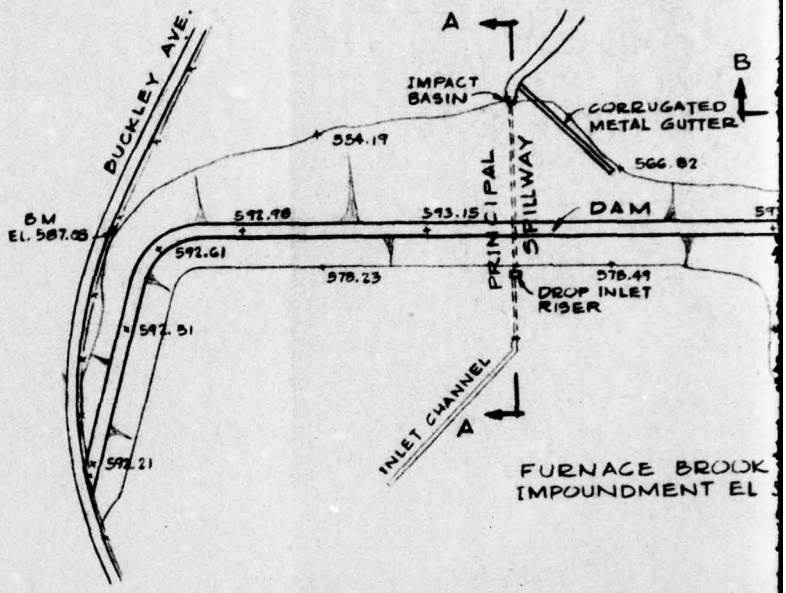
SCALE: 1" = 4'



PLAN



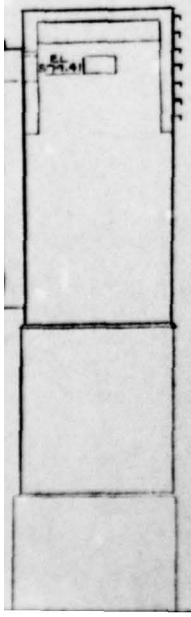


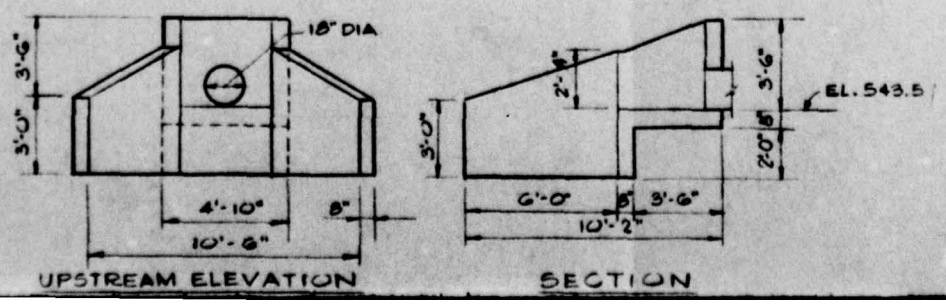


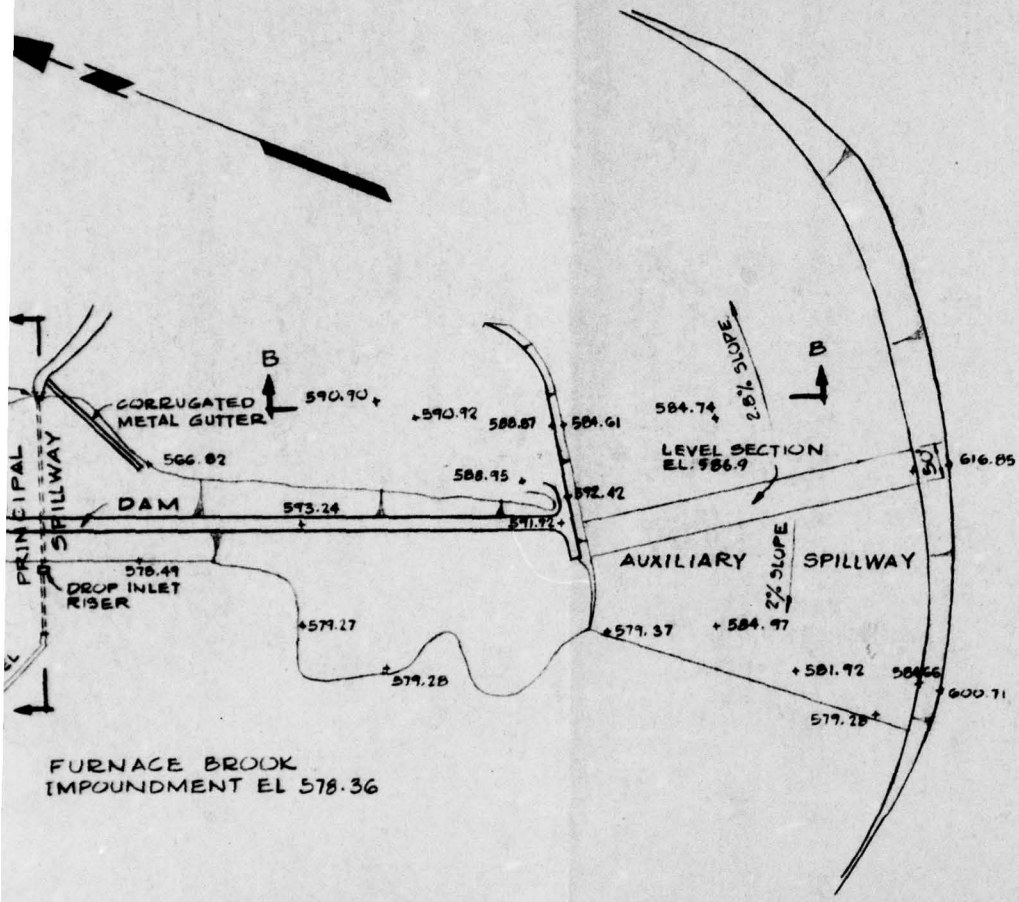
FURNACE BROOK
IMPOUNDMENT EL

PLA

SCALE:



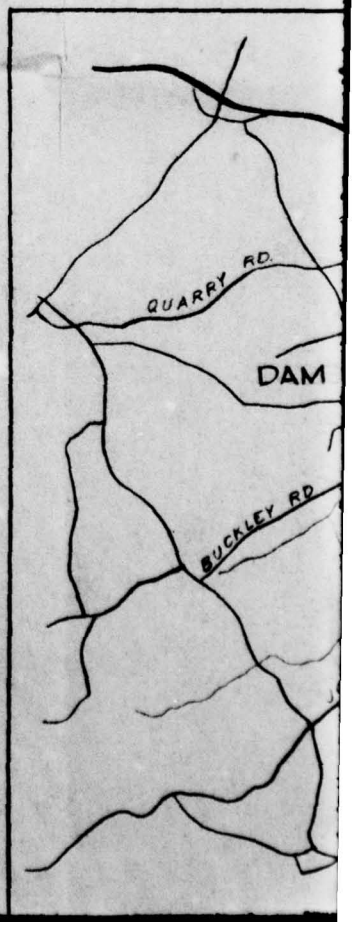




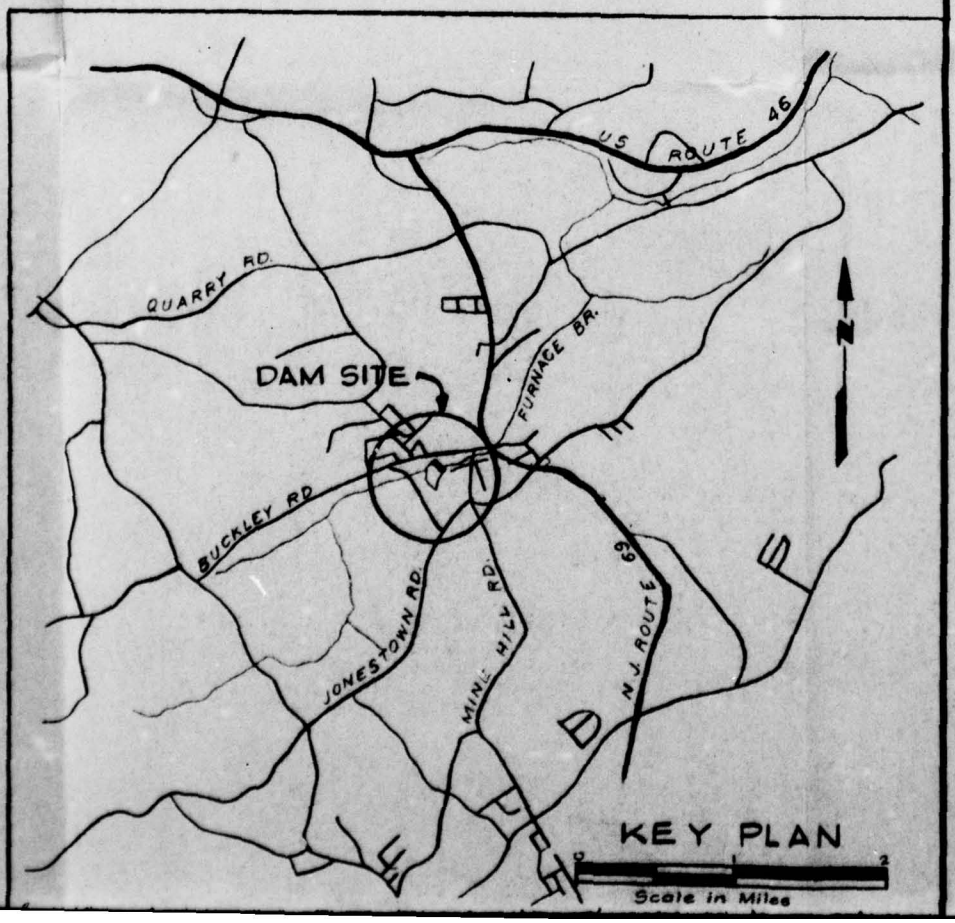
FURNACE BROOK
IMPOUNDMENT EL 578.36

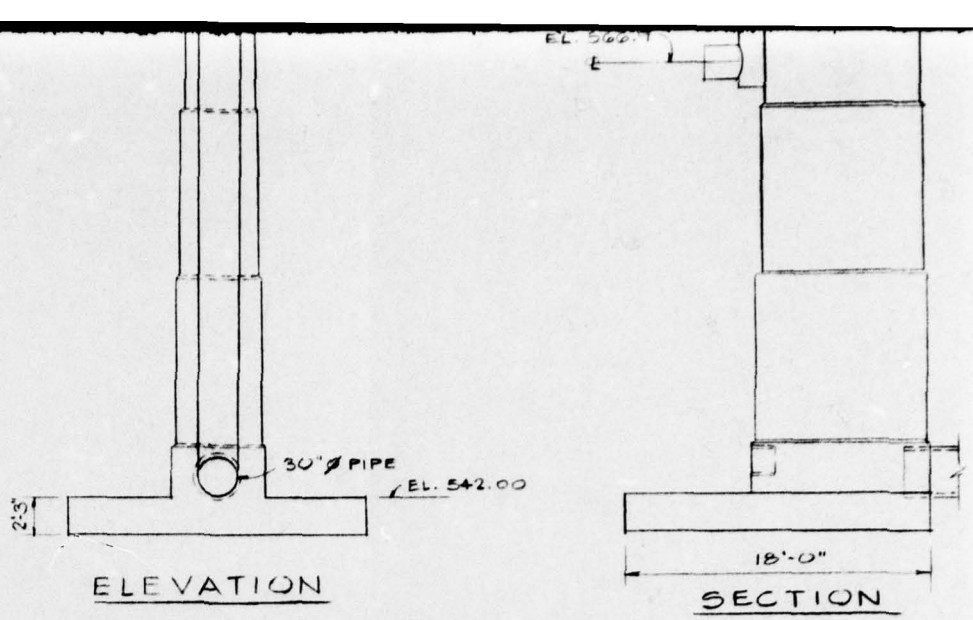
PLAN

SCALE : 1"=200'



EL. 543.5


US ROUTE 46
QUARRY RD.
DAM SITE
FURNACE BR.
BUCKLEY RD
JONESTOWN RD.
MINE HILL RD.
N.J. ROUTE 69
N
KEY PLAN
0
1
2
Scale in Miles

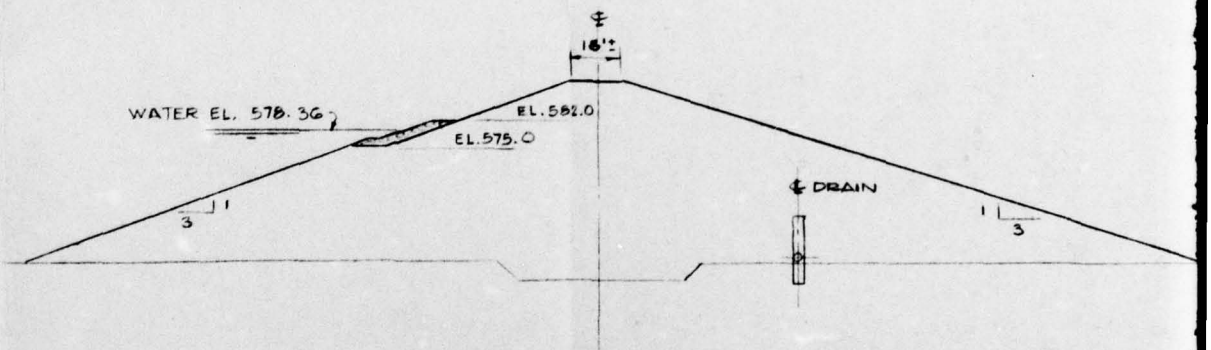


ELEVATION

SECTION

DETAIL OF DROP INLET RISERS

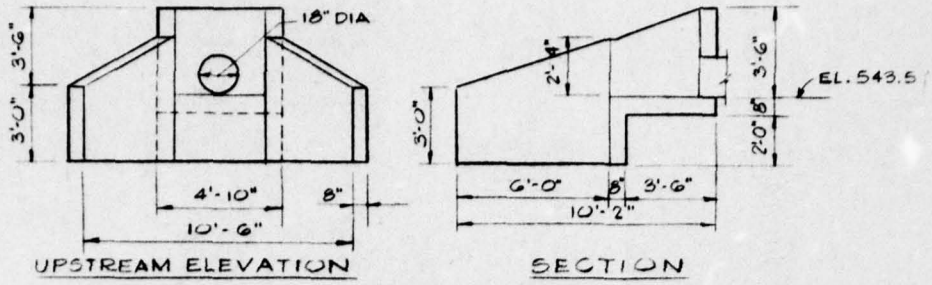
SCALE : 1" = 8'



TYPICAL SECTION THRU DAM

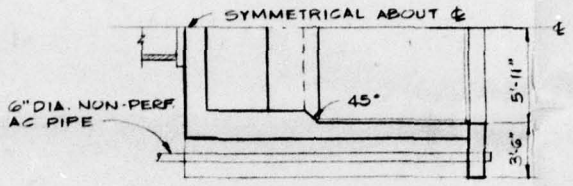
SCALE : 1" = 4'

5

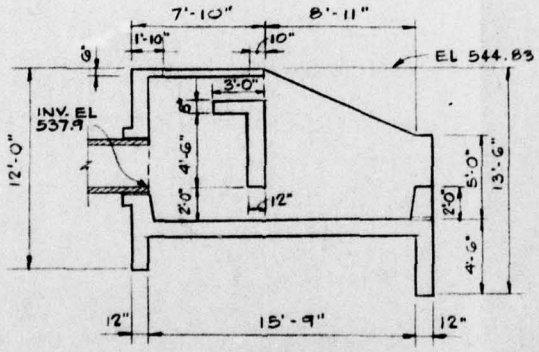


REINFORCED CONCRETE RESERVOIR DRAIN INLET

N.T.S.



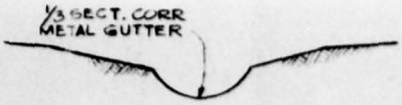
PLAN

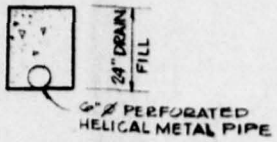


SECTION

REINFORCED CONCRETE IMPACT BASIN

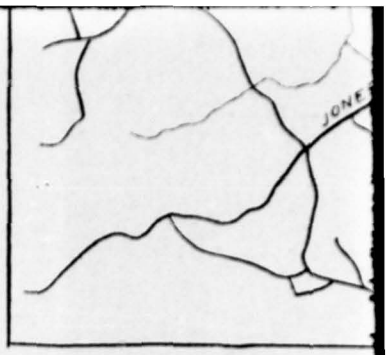
SCALE : 1" = 8'

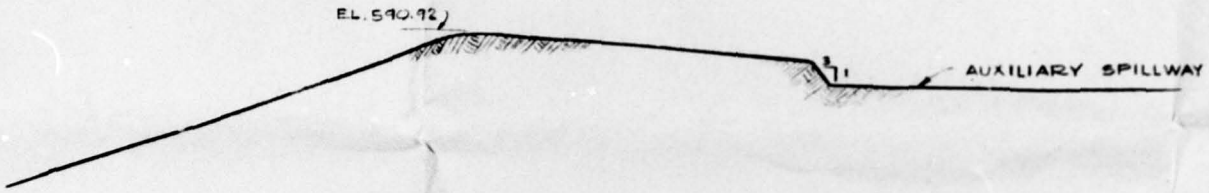




CORRUGATED METAL GUTTER

N. T. S.



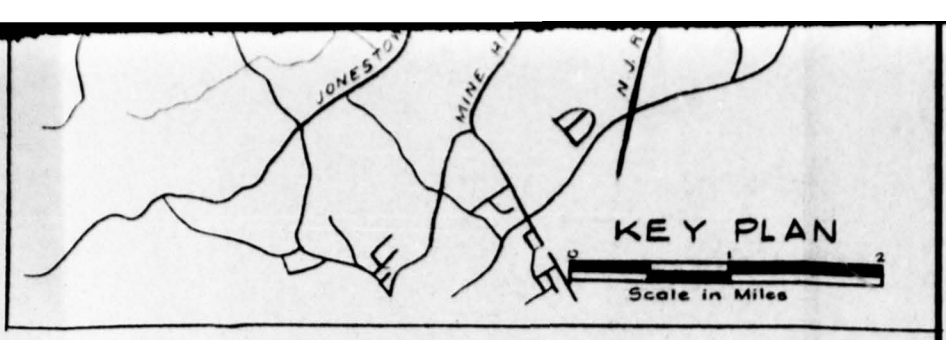


SECTION B-B

SCALE: HORIZ: 1" = 100'
VERT: 1" = 20'

NOTE:

THE ELEVATIONS SHOV
SURVEYOR'S TRANSIT AND
"FURNACE BROOK WATER SHED
BY THE U.S. DEPT. OF AGRICU
A SELECTED BENCH MARK EL
POWER POLE # 18 AS INDICATE
ARE APPROXIMATE. INFORMA
AND WATER LEVEL ARE INFE
MENTIONED DWGS.



AUXILIARY SPILLWAY

NOTE:

THE ELEVATIONS SHOWN WERE OBTAINED USING A SURVEYOR'S TRANSIT AND LEVEL AND THE DWGS. ENTITLED "FURNACE BROOK WATERSHED MULTIPLE PURPOSE DAM NO. 2" BY THE U.S. DEPT. OF AGRICULTURE SOIL CONSERVATION SERVICE. A SELECTED BENCH MARK ELEVATION OF 587.05 WAS USED FROM POWER POLE # 18 AS INDICATED ON SAID DWGS. THESE ELEVATIONS ARE APPROXIMATE. INFORMATION SHOWN BELOW GROUND SURFACE AND WATER LEVEL ARE INFERRED ON THE BASIS OF THE ABOVE MENTIONED DWGS.

DATE	DESCRIPTION
REVISIONS	

PROJECT

PHASE I

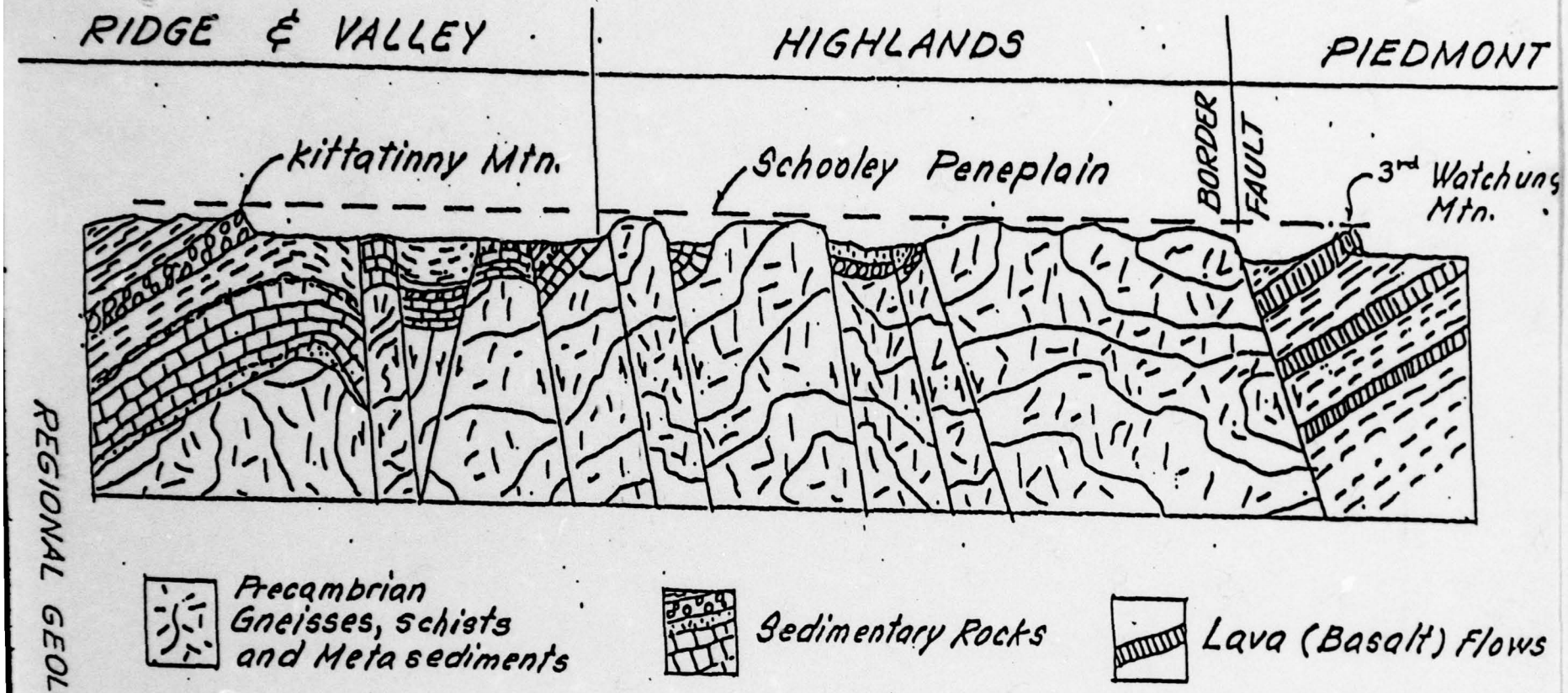
INSPECTION & EVALUA
of
NEW JERSEY DAMS

DRAWING TITLE

FURNACE BROO
WATERSHED DAM N

FEBRUARY 19
FED. I.D NO. NJ001

JOB NO. J-7856	DRAWING NO. FIG.
DATE 1 FEB 1979	
SCALE AS NOTED	
DRN. BY J.B.	



REGIONAL GEOLOGIC FEATURES

Fig. 3

Schematic Cross-section
New Jersey Highlands
Physiographic Province
(After Wolfe; 1977)

APPENDIX 1

ENGINEERING DATA

FURNACE BROOK W.S. DAM #2

1. DESIGN REPORT, 6 pages
2. SOIL MECHANICS LABORATORY REPORT, 22 pages
3. LOGS OF DRILL HOLES AND TEST PITS, 18 pages
4. DETAILED GEOLOGIC INVESTIGATION OF FURNACE BROOK SITE 2, 11 pages
5. OPERATION AND MAINTENANCE AGREEMENT FOR STRUCTURAL MEASURES, 8 pages

DESIGN REPORT

NJ-08-2013-2

Multiple Purpose Dam No. 2
Furnace Brook Watershed
Warren County
New Jersey

Location:

This multiple purpose dam of the Furnace Brook Watershed Project is located in Warren County approximately one mile upstream from Oxford on Furnace Brook. The site has a drainage area of 2.87 square miles and controls 61.4 percent of the drainage area contributing to the damage reach in Oxford.

Hydrology, Work Plan Stage:

No principal spillway routings were made through Furnace Brook Site 2 in the planning stage.

The 100-year 6, 24, 48, 72 and 96 hour duration hydrographs were routed through the now deleted Site 1 which was approximately 2600 feet downstream from the present site. The routings were performed by use of Soil Conservation Service Technical Release 20, Computer Program for Project Formulation. The highest elevation obtained from the above five routings was then established as the emergency spillway crest for Site 1. This elevation, 554.8 feet, and the associated flood storage, 635 acre feet, was obtained from the 100-year 48 hr. storm.

To determine the flood storage required in Site 2 a ratio of its drainage area, 2.87 sq. miles, to that of Site 1, 3.74 sq. miles, was multiplied by the storage required in Site 1 to give 487 acre ft. This resulted in an emergency spillway crest elevation of 586.9 ft.

The emergency spillway and freeboard designs were determined from hydrographs produced by rainfalls taken from hydrologic maps based on U.S. Weather Bureau Technical Paper No. 40. The SCS Technical Release 35 was used for routing these storms through Site 2.

Hydrology, Design Stage:

The first routings made were those in accordance with the Soil Conservation Service National Engineering Handbook, Section 4, Chapter 21, Design Hydrographs. The resulting emergency spillway crest elevation of 587.99 feet is approximately 1.0 foot higher than that established in the work plan.

In accordance with Engineering Memorandum No. 67, the procedure used in the planning stage was then followed.

REFERENCE:	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. NJ-08-2013-2 SHEET 1 OF ____ DATE ____

Therefore, following the procedure used in the work plan, the 100-year frequency 6, 24, 48 and 72 hour duration storms were routed through Site 2. The curve number and time of concentration used were those established for Site 2. The inches of rainfall associated with each storm checked exactly with those used in the planning stage when routing through Site 1. Again the 100-year 48 hour storm gave the maximum required flood storage, 400 acre feet. This is 87 acre feet less than that established in the planning stage.

Since current criteria requires that more storage be provided than that established in the work plan, it was felt advisable to provide at least the storage required in the work plan rather than reduce it by 87 acre feet. The emergency spillway crest elevation was therefore set at 586.9 feet.

The drawdown calculation showed that more than 80% of the flood storage will be removed within 10 days. Therefore, the emergency and freeboard hydrographs were routed from the normal pool elevation of 579.0. The elevations obtained were in close agreement with those established in the work plan.

All routings were performed by the Automatic Data Processing Section in Upper Darby, Pennsylvania, in accordance with TSC-Technical Note-MGT-UD3.

Hydraulics:

The principal spillway is a drop inlet structure consisting of a two stage reinforced concrete riser, 30 inch diameter reinforced concrete water pipe, and reinforced concrete impact basin. The riser is of a standard design developed by the Agricultural Research Service at the Saint Anthony Falls Hydraulic Laboratory, Minneapolis, Minnesota. The impact basin is also of a standard design adapted from that developed by the Bureau of Reclamation, U.S. Department of Interior. This type of energy dissipator functions almost independently of tail water elevation.

The auxiliary spillway is an open channel excavated in the right (South) abutment. It consists of a negatively sloped entrance, a level reach of 50 feet, a control section, and a positively sloped outlet. The bottom width is 500 feet. The dike being built along its north side will be ripraped.

Subsurface Investigation:

The subsurface investigation was conducted by the staff geologist of the Soil Conservation Service in coordination with the design engineer. Test pits and drill holes were used in the investigation. Laboratory

tests were conducted and the test report prepared by the Soil Mechanics Laboratory of the Soil Conservation Service in Lincoln, Nebraska. For a detailed report of the site investigation, interpretations, conclusions, and laboratory results see the section headed Geology and Soils.

Embankment:

The earth fill embankment consists of material classified as CL-ML. The side slopes shall be 3:1 both upstream and down with a ripraped berm on the upstream side. The downstream face shall be covered with rock obtained from on site material. A vertical embankment drain will be constructed to provide for drainage in the embankment. Relief wells are being placed at the downstream toe to relieve excess pressure.

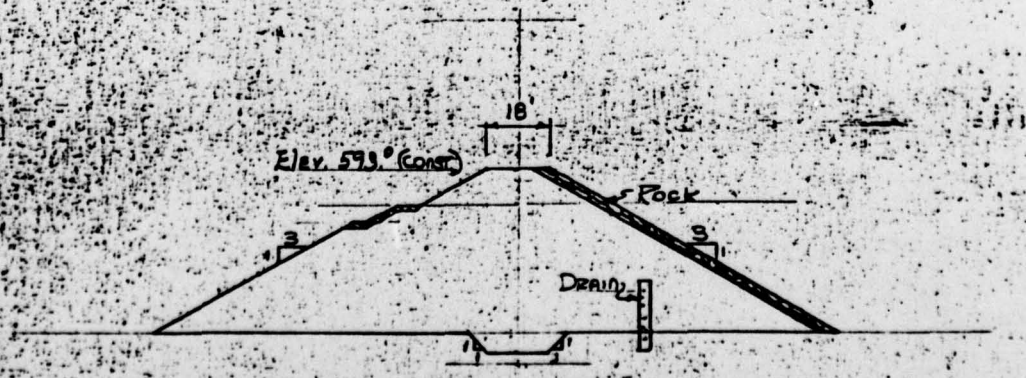
PREPARED BY: C. Montana
Carmelo J. Montana
Design Engineer

CONCURRED BY: KSW
Kenneth S. Werkman
State Conservation Engineer

U.S. DEPARTMENT OF AGRICULTURE = SOIL CONSERVATION SERVICE

DESIGN REPORT SUMMARY

I. Watershed Data		
A. Structure Class	C ?	
B. Drainage Area	1837	Ac.
C. Time of Concentration - T_c	1.2	Hrs.
D. Hydrologic Curve Number - C_n		
1. Moisture Condition II	69	
II. Principal Spillway		
A. Conduit		
1. Inside Dia.	30	In.
2. Length	232	Ft.
B. Riser		
1. Inside Dimensions	2.5 x 7.5	Ft.
2. Height (Floor to Crest)	39.25	Ft.
C. Weir Length	15.0	Ft.
D. Orifice Dimensions	1.5 x 2.92	In.
E. Reservoir Drain Size	18	In.
F. Type of Energy Dissipater	Impact Basin	
III. Emergency Spillway		
A. Width	500	Ft.
B. Side Slopes	3:1, 3:1	
C. Length of Level Section	50	Ft.
D. Exit Slope	.033	Ft./Ft.
E. Max. Velocity in Exit Section @ D.H.W.	5.3	Ft./Sec.
F. Duration of Flow thru Emer. Spillway @ D.H.W.	5	Hrs.
G. Frequency of Use	Once every 100 years	
IV. Earth Fill		
A. Height	53.0	Ft.
B. Volume	193,800	C.Y.
C. Compaction	A 1	



FILL PLACEMENT

REFERENCE:

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

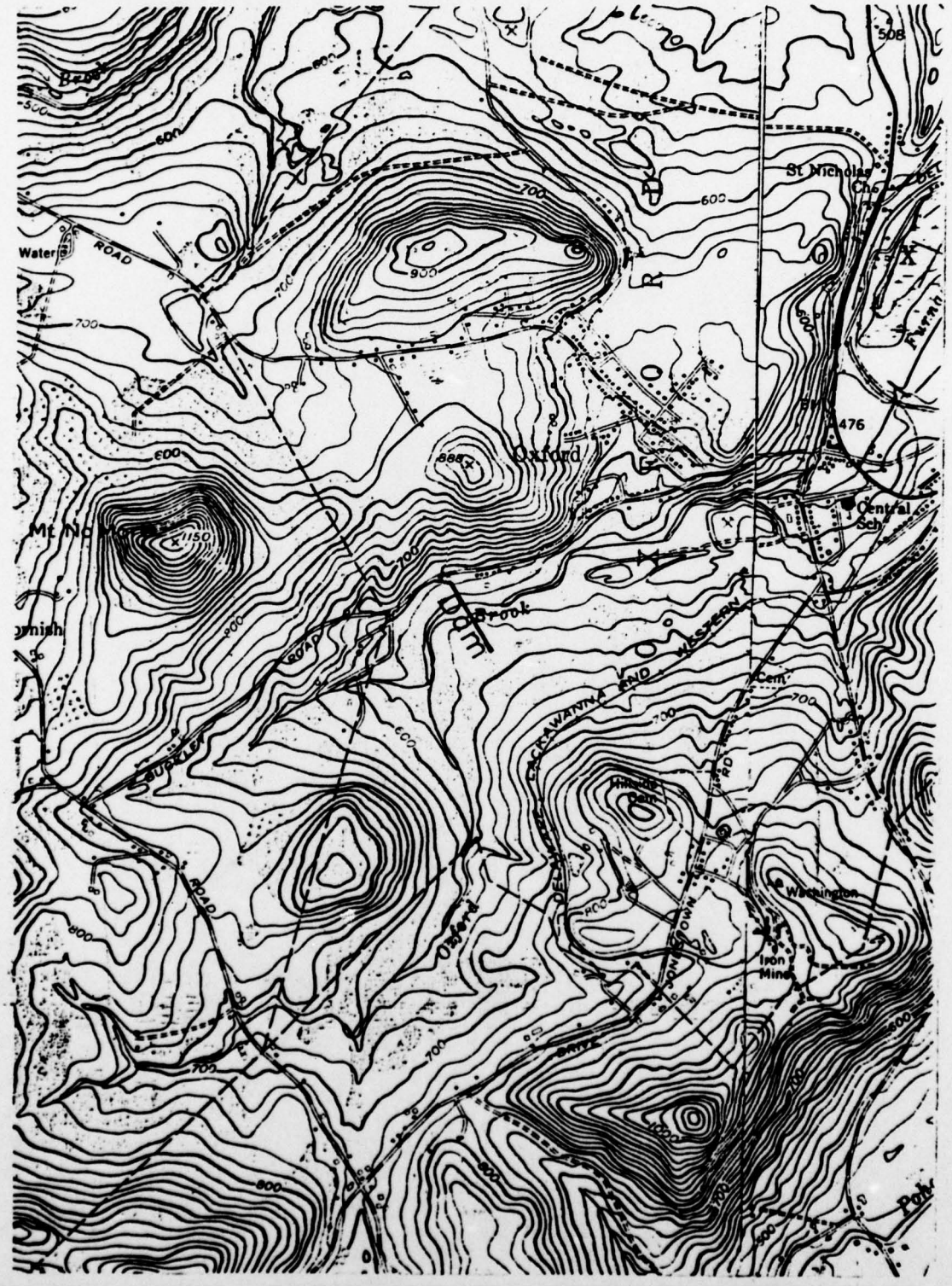
DRAWING NO. NJ-08-2013-2
SHEET 5 OF ____
DATE ____

DESIGN REPORT

SITE 2 FURNACE BROOK WATERSHED

ELEMENT OF STRUCTURE	DETERMINING FACTOR	ELEVATION (Ft)	SURFACE AREA (Ac)	STORAGE (Ac-Ft)	PEAK INFLOW (cfs)	RAINFALL (in)	RUNOFF (in)
Inverts of low stage	50 year sed. plus beneficial storage	579.0	53.0	640	-	-	-
Crest of Riser	Vol. Req'd for desired level of protection	581.25	57.0	760	-	-	-
Crest of Auxiliary Spillway	100 yr. 48 hr. storm hydro-graph	586.9	68.0	1120	893	8.4	4.81
Design High Water	Auxiliary Spillway Hydro-graph Rainfall from ES 1020 SH 4 of 5	588.6	72.0	1240	4815	10.4	6.45
Top of Dam	Freeboard Hydrograph Rainfall from ES 1020 SH 5 of 5	591.6	75.5	1440	15,888	25.3	20.60

LOCATION MAP



REFERENCE:

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DRAWING NO.
NJ-08-2013-2

SHEET 6 OF ____

DATE ____

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory
800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, New Jersey WP-08, Furnace Brook Site No. 2 (Warren County)

DATE: December 19, 1969

TO: K. S. Werkman, State Conservation Engineer
SCS, Somerset, New Jersey 08873

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 2 sheets.
2. Form SCS-128, Consolidation Test Data, 1 sheet.
3. Form SCS-127, Soil Permeability, 2 sheets.
4. Form SCS-355A & B, Triaxial Shear Test Data, 2 sheets.
5. Form SCS-352, Compaction and Penetration Resistance, 2 sheets.
6. Form SCS-523, Foundation Permeability - Summary of Field Test Data, 6 sheets.
7. Form SCS-357, Summary - Slope Stability Analysis, 2 sheets.
8. Form SCS-130, Drain Materials, 1 sheet.

DISCUSSION

FOUNDATION

A. Bedrock. The bedrock at this site is granitoid gneiss. It was encountered on the left abutment at a depth of 36.5 feet in DH-2 and at a depth of 28 feet in DH-1. It was not encountered on any of the other borings on the site and the test holes penetrated to depths of about 75 feet in the bottom of the valley and to depths of about 72 feet on the right abutment.

B. Soil Classification. The only samples submitted from the foundation were obtained from the 2 to 4-foot depth, and they represent the surface glacial till and the alluvium. The samples submitted contained from 20 to 55 percent fines. Atterberg limit tests were not made on these samples, but based on the Atterberg limits of the borrow samples, it appears that the samples submitted from the drain line will fall within the SM and ML classification.

The foundation materials at this site are described in the geology report, and the stratigraphy is very well outlined on the profiles and geologic section of Form SCS-316C.

The foundation materials as outlined consist of glacial till, lacustrine sediments, interglacial fluvial materials, and older glacial till overlying bedrock. The material at the surface is essential glacial till and alluvium although the interglacial sandy material is exposed in some areas. The interglacial alluvium occurs in the old channel sections

both above and below the lacustrine deposit. The old channel sections are irregular and meander through the foundation. The location of the interglacial channel sections is well outlined in the investigational report.

Foundation samples were not submitted for shear strength and consolidation testing. The investigational data show high blow counts in most materials.

C. Permeability. A number of field permeability tests were made and the data are recorded in the geology report. These data are summarized by soil material on the attached Forms SCS-523.

EMBANKMENT

A. Soil Classification. Two samples were submitted to represent the embankment material. These samples represent glacial till. They contain about 10 percent gravel and slightly over 50 percent fines. One of the samples has an LL of 27 and a PI of 7. It is classed as CL-ML. The other sample has an LL of 31 and a PI of 11, and it is classed as CL.

B. Compacted Density. Standard Proctor compaction tests were made on the minus No. 4 fraction of each of the samples. The maximum dry density obtained was 117.5 pcf on 70W689 and 118.0 pcf on 70W690.

C. Shear Strength. The two samples are quite similar, so a consolidated undrained triaxial shear test was made on Sample 70W689 to represent these materials. The test was made at 95 percent of standard Proctor density, and the test specimens were back pressured to obtain saturation. Pore pressure was measured during the undrained shear test. The total stress shear strength parameters obtained are $\phi = 20°$, $c = 425$ psf; and the effective stress shear strength parameters are $\bar{\phi} = 30.5°$, $\bar{c} = 300$ psf.

D. Consolidation. A consolidation test was made on Sample 70W689. The test specimen was compacted to 95 percent of Proctor density by kneading compaction. The data obtained are shown on the attached Form SCS-128. The data indicate that this material will consolidate about 0.05 ft/ft at the base of the embankment.

E. Permeability. A permeability test was made on Sample 70W689 at 95 percent of standard Proctor density. The test was made in an 8-inch diameter permeameter under loads of 500 psf and 2,000 psf. The permeability rate measured was 0.003 fpd under both loads. The data are shown on the attached Form SCS-127.

In addition to the permeability test outlined above, permeability measurements were made on the consolidation test specimen under loads of 2,000 psf, 4,000 psf, 8,000 psf, and 16,000 psf. The rates obtained are shown on the attached Form SCS-127, sheet 2 of 2.

SLOPE STABILITY

A stability analysis was made with a Swedish circle method of analysis. The foundation materials have high blow counts, and they are described as dense. No samples of the foundation were submitted for testing, however, and for this analysis it was considered to be sufficiently strong so that the trial failure arcs were limited to the embankment. The analysis for the upstream slope considered drawdown from emergency spillway elevation, and the analysis for the downstream slope considered the steady seepage condition with a phreatic line from emergency spillway elevation to a drain at the c/b = 0.6 point.

With the shear strength values of $\phi = 20°$, c = 425 psf representing the embankment material, the factor of safety for the upstream slope was 1.44 and the factor of safety for the downstream slope was 1.83.

CONCLUSIONS AND RECOMMENDATIONS

The following recommendations concerning cutoff and drainage are a result of discussion between representatives from the E&WP Unit, the State Design Engineer, and myself at the E&WP Unit office on December 9, 1969.

A. Cutoff. We concur with the cutoff trench depths suggested by the State Design Engineer, as shown on Form SCS-316E of the investigation report. At the depths proposed the trench will bottom in either glacial till or in lacustrine material. When the trench is opened in the left abutment it will be necessary to determine whether the boulders encountered in the till during the site investigation occur in pockets or in lenses. If they occur in lenses, it may be necessary to extend the cutoff.

A trench width of H - d, as planned, should be sufficient; and based upon the gradation of the alluvial samples submitted, it does not appear that a transition zone will be required between the glacial till trench backfill and the alluvium. This will require more evaluation at the time the trench is opened, however, to make certain that the trench backfill will not pipe into coarse-grained alluvium if it exists.

The till represented by the borrow samples is suitable for trench backfill, and we recommend that it be placed at a minimum of 95 percent of Proctor density with the control based on the minus No. 4 fraction. A placement moisture content slightly wet of optimum is suggested.

B. Drainage. The following measures are recommended to control seepage:

1. Install a foundation trench drain at about c/b = 0.6 to provide a safe outlet for foundation and embankment seepage. We suggest that the trench penetrate the foundation a minimum of 5 or 6 feet. If more permeable zones occur below the 5 or 6-foot depth in the alluvium, we suggest that the trench be deepended to outlet these zones. This may also be necessary on the abutments if the interglacial fluvial materials are encountered in the drain trench.

We concur with the proposal to carry the foundation drain up the abutments to normal pool elevation.

The range in gradation of the foundation materials is quite wide, and there is a good possibility that a wider range occurs than shown on the attached Form SCS-130; therefore, we suggest that a double element filter be installed with gradations like those shown on the attached Form SCS-130.

More positive control of the phreatic line might be obtained by utilizing some of the sandy material from an upstream location in a portion of the downstream section than by relying on the permeability of the alluvium and the foundation drain to control the phreatic line in the embankment.

2. It was concluded on the basis of the investigational data and from approximations using the blanket-aquifer equations that relief of the interglacial alluvium underlying the lacustrine material is required. The interglacial alluvium is stratified, and the more permeable zones occur at depths greater than can be handled with the trench drain; therefore, relief wells are necessary. It was the consensus of the group during the discussion on this site that three relief wells should be installed at the downstream toe. The approximate location suggested is in the vicinity of DH-302 and 50 feet on either side of DH-302. It is also suggested that observation wells be installed on both sides of the relief wells. The wells should extend either to the underlying glacial till or to the most pervious stratum in the interglacial fluvial material if this can be determined.

   The interglacial fluvial deposit is expected to be stratified, and the gradation may vary considerably within relatively short distances; therefore, it will be necessary to determine the gradation of all of the material at the well location and design the filter pack on the basis of the materials encountered.

3. We concur with the proposal to place a compacted soil blanket over the exposed sandy deposits upstream from the embankment on the left abutment.

   On the basis of the present data, it does not appear that the seeps on the left abutment upstream from the dam will cause any problems.

C. Principal Spillway. High-blow-count material occurs at the proposed location, and it is reported that foundation consolidation is expected to be very low.

D. Embankment Design.

1. Placement of Material. Materials represented by the two borrow samples submitted make up the majority of the fill. We suggest that this material be placed at a minimum of 95 percent of standard Proctor optimum with the control based on the minus No. 4 fraction. We suggest a placement moisture content slightly wet of optimum to obtain as much flexibility in the fill as possible.

2. Slopes. The data indicate that the proposed 3:1 slopes have acceptable factors of safety.

3. Settlement. An overfill allowance of 1.25 feet is suggested to compensate for residual settlement in the fill and foundation.

Prepared by:

Lorn P. Dunnigan

Lorn P. Dunnigan

Attachments

cc:
K. S. Werkman (2)
Neil F. Bogner, Upper Darby, Pa.

Rev. 3/59

9/26/69 Ht. = 51.5' Class "c"
177,000 cu yd Floodwater Retarding, Sediment Storage, and Recreation

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NEW JERSEY

LABORATORY SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH	FIELD CLASSIFICATION	MECHANICAL ANALYSIS — GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT: FINES					SAND						GRAVEL						ATTERB. LIMITS		UNIFIED CLASSIFICATION	SOLUBLE SALTS %	DISPERSION %
					0.002 mm	0.005	0.02	0.05	#200 0.074	#140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	L.L.	P.I.			
70W		Furnace Brook Site: 2																								
682	D-303	Trench Drain, 70' R ℄ Dam 14+70 A	2-4'	SW-SM	9	13	15	20	20	22	30	40	59	74	81	86	90	93	100							
		Alluvium																								
683	D-2	Trench Drain, 30' R ℄ Dam 9+35 B	2-4'	SM	9	12	17	29	30	32	39	45	55	62	65	70	73	80	92	100						
		Glacial Till					30%					40%						30%								
684	D-12	Trench Drain, ℄ Dam 17+00 B	2-4'	SM	18	25	36	45	45	48	58	65	75	82	88	91	92	100								
		Glacial Till					42%					37%						12%								
685	D-601	Trench Drain, 70' R ℄ Dam 11+90 B	2-4'	SM	13	21	34	50	55	60	73	81	90	96	99	100										
		Glacial Till																								
686	D-602	Trench Drain, 95' R ℄ Dam 13+00 B	2-4'	SM	8	13	21	32	36	40	57	66	76	81	84	86	88	92	95	100						
		Glacial Till																								
687	D-604	Trench Drain, 75' R ℄ Dam 14+30 A	2-4'	SP-SM	6	9	12	17	17	20	42	68	83	85	86	86	88	87	91	100						
		Alluvium																								

Form SCS-356
Rev. 3/59

9/26/69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 2 of 2

NEW JERSEY

LABORATORY SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH	FIELD CLASSIFICATION	MECHANICAL ANALYSIS — GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT																	ATTERBERG LIMITS		UNIFIED CLASSIFICATION	SOLUBLE SALTS %	DISPERSION %	MOISTURE - DENSITY RELATIONSHIPS ☒ STANDARD ☐ MODIFIED			UNDISTURBED SAMPLE DATA		G_s	SPECIAL TESTS				
					CLAYS			SILT		SAND						GRAVEL						LL	PI				CURVE NO	MAX. γ_d pcf	w_o %	γ_d g/cc	w_o %					
					0.002 mm	0.005	0.02	0.05	#200 0.074	#140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm															
70W		Furnace Brook Site: 2																																	
688	D-605	Trench Drain, 60' R ℄ Dam 14+90 B	2-4'	SM	14	23	32	41	43	46	58	67	78	87	91	94	97	100																	
		Glacial Till																																	
689	4	Aux. Spillway, 70' R L. Bag 1091 ℄ Dam 26+15 B	2-10'	SC	17	27	41	50	51	53	63	70	78	86	91	94	96	97	98	100		27	7	CL-ML										2.75	✓	✓	✓		
		Glacial Till																					DRY	DENSITY < NO. 4			①	117.5	13.5							
690	6	Aux. Spillway, 630' R L. Bag 1141 ℄ Dam 23+20 B	2-8'	SC	20	29	43	51	52	55	64	70	77	85	89	93	94	96	97	99	100	31	11	CL										2.78					
		Glacial Till																					DRY	DENSITY < NO. 4			②	118.0	15.0							

Form SCS 128
9-64

LABORATORY NO 70WC69

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	CONSOLIDATION TEST

PROJECT and STATE: FURNACE BROOK NO 2 NEW JERSEY

SAMPLE LOCATION: AUX SPWY 70'R @ DAM 2+11.5

FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
4	2.0'-10.0'	Glacial Till

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
Compacted	SML-LINCOLN	LPD	12-13-69

CLASSIFICATION CL-ML

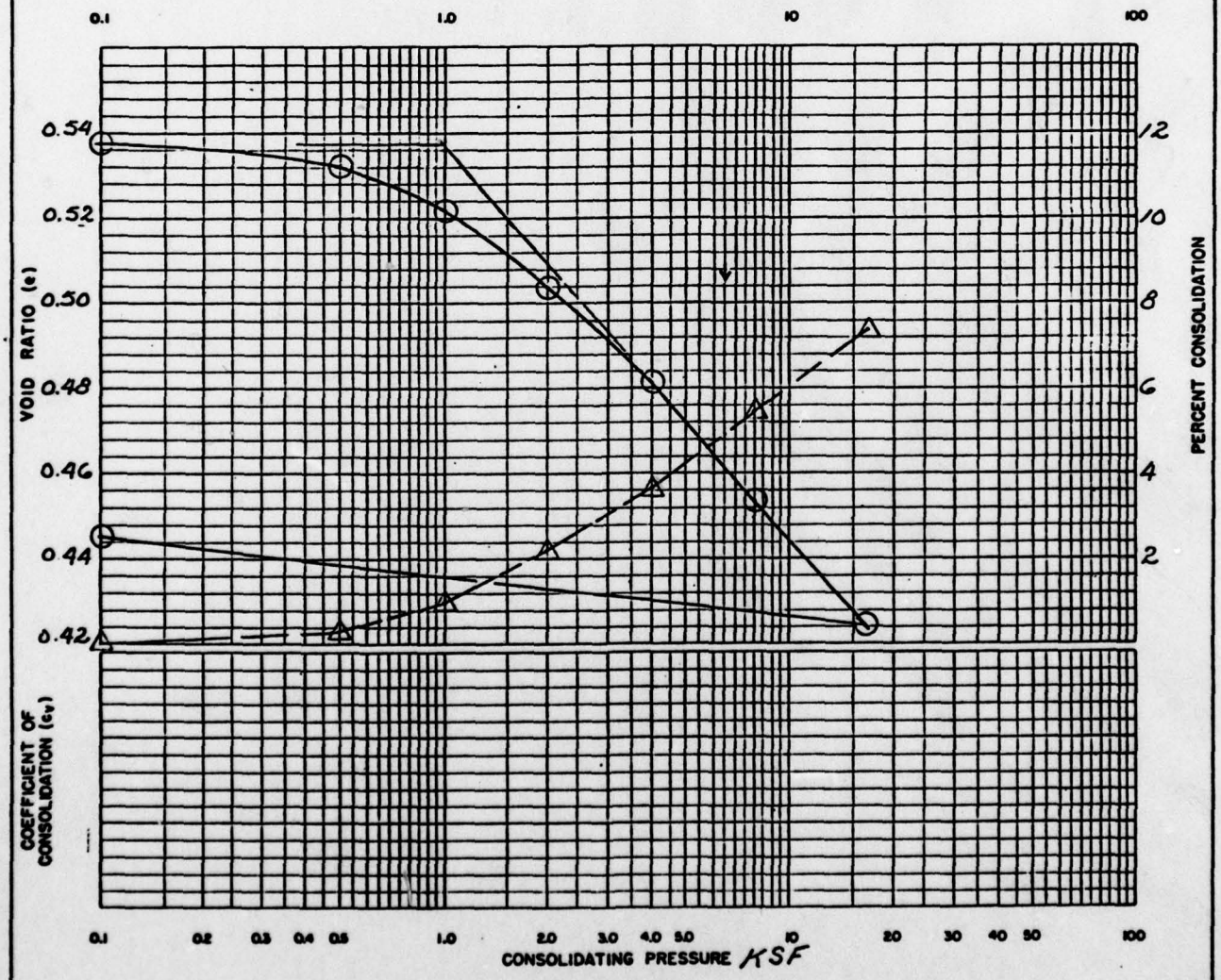
G_s 2.75 LL 27 PI 7

INITIAL DENSITY γ_d 1.789 g/cc - 111.7 pcf

INITIAL VOID RATIO, e_o 0.5373

COMPRESSION INDEX, C_c 0.193

TEST SPECIFICATIONS:
Saturated at Start



REMARKS

Sheet 1 of 2 LABORATORY NO 70X1699

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SOIL PERMEABILITY

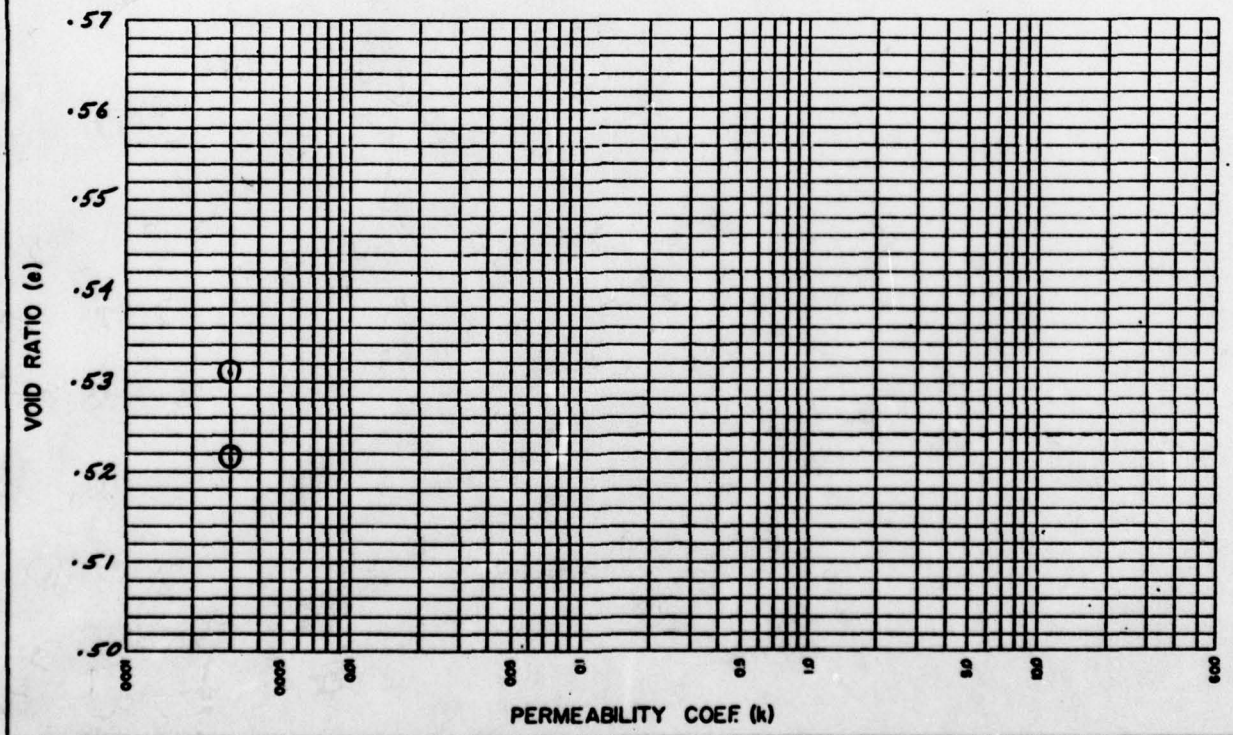
PROJECT and STATE: Furnace Brook #2 New Jersey
SAMPLE LOCATION: Aux. Spillway
FIELD SAMPLE NO.: 4
DEPTH: 2'-10'
GEOLOGIC ORIGIN:
TYPE OF SAMPLE: Disturbed
TESTED AT: S.M.L. Lincoln
APPROVED BY:
DATE:
CLASSIFICATION: CL-ML LL 22 PI 7

TEST NO.	1	2	3	4
LOAD psf	500	2000		
DRY DENSITY □ g/cc ⊠ pcf	112.1	112.8		
VOID RATIO	0.5308	0.5218		
VOLUME CHANGE %	-0.4	-1.0		
PERMEABILITY COEF. fpd	0.003	0.003		
H/L DURING TEST	1.6420	1.6530		

SPECIFIC GRAVITY

G_s (-) #4	2.75
G_s (+) #4	
G_m (Bulk)(+) #4	

TEST SPECIFICATIONS
Material < #4 compacted to 95% std. in 8.0" dia. permeameter
Constant Head Test



REMARKS

Sheet 2 of 2 LABORATORY NO [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SOIL PERMEABILITY

PROJECT and STATE: FURNACE BROOK NO 2 NEW JERSEY

SAMPLE LOCATION: AUX SPWY 70' R & DIM 24+15

FIELD SAMPLE NO: 1

DEPTH: 2.0'-10.0'

GEOLOGIC ORIGIN:

TYPE OF SAMPLE: Compacted

TESTED AT: SML-LINCOLN

APPROVED BY:

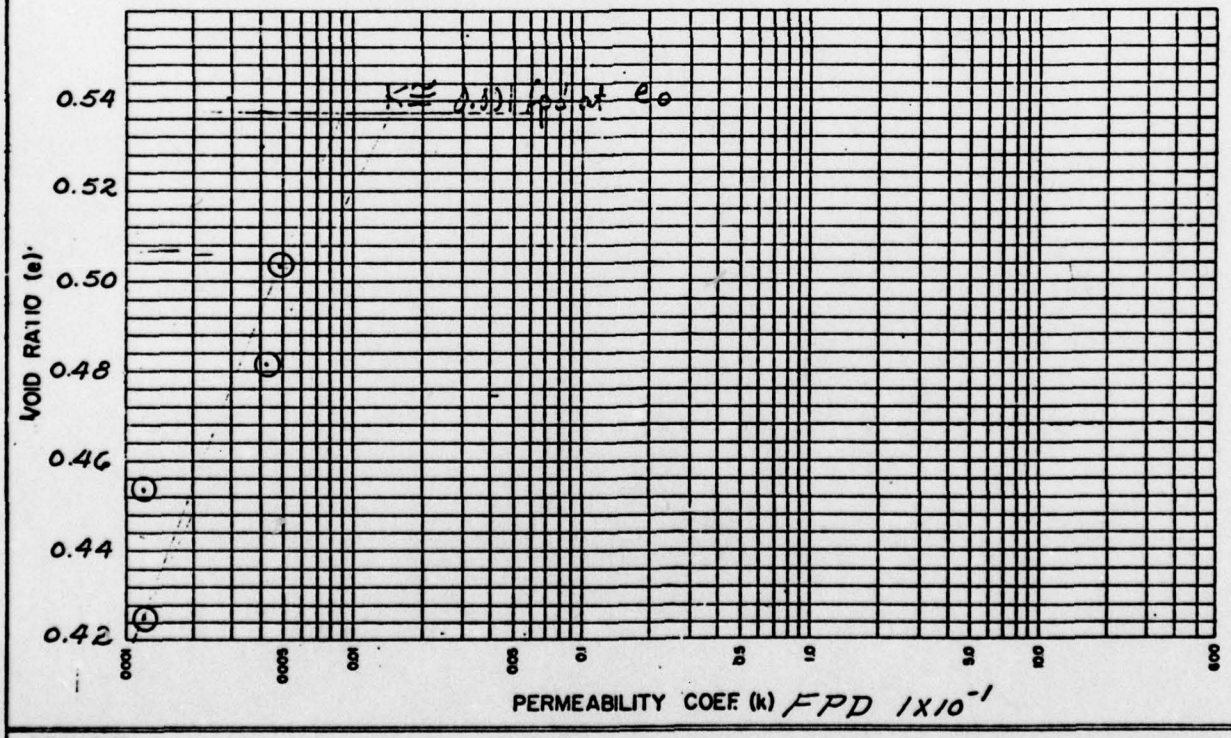
DATE:

CLASSIFICATION CL-ML LL 27 PI 7

SPECIFIC GRAVITY

TEST NO.	1 2000	2 4000	3 8000	4 16000		
INITIAL MOISTURE %					G_s (-)#4	2.75
DRY DENSITY ☒ g/cc ☐ pcf	1.83	1.86	1.89	1.93	G_s (+)#4	
VOID RATIO	0.5038	0.4815	0.4535	0.4248	G_m(Bulk)(+) #4	
PERMEABILITY COEF. FPD	0.00049	0.00043	0.00012	0.00012		
PERCOLATION COEF						
H/L DURING TEST						

TEST SPECIFICATIONS
Falling Head Perm Test on The Consolidation Sample



REMARKS

Form SCS 355A
Rev 6-65

LABORATORY NO 70111159

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: FURNACE BROOK SITE 2 NEW JERSEY
SAMPLE LOCATION: AUX. SPILLWAY 70'R & FROM 26+15
FIELD SAMPLE NO.: 4
DEPTH: 2-10'
GEOLOGIC ORIGIN: Glacial Till
TYPE OF SAMPLE: COMPACTED
TESTED AT: SML-LINCOLN
APPROVED BY: LPD
DATE: 12-15-69

INDEX TEST DATA

USCS CL-ML ; LL 27 ; PI 7
% FINER (mm): 0.002 17 ; 0.005 27 ;
0.074 (# 200) 51
G_s (-#4) 2.75 ; G_s (+#4) _____
STANDARD: γ_d MAX. 117.5 pcf; w_o 13.5 %
MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

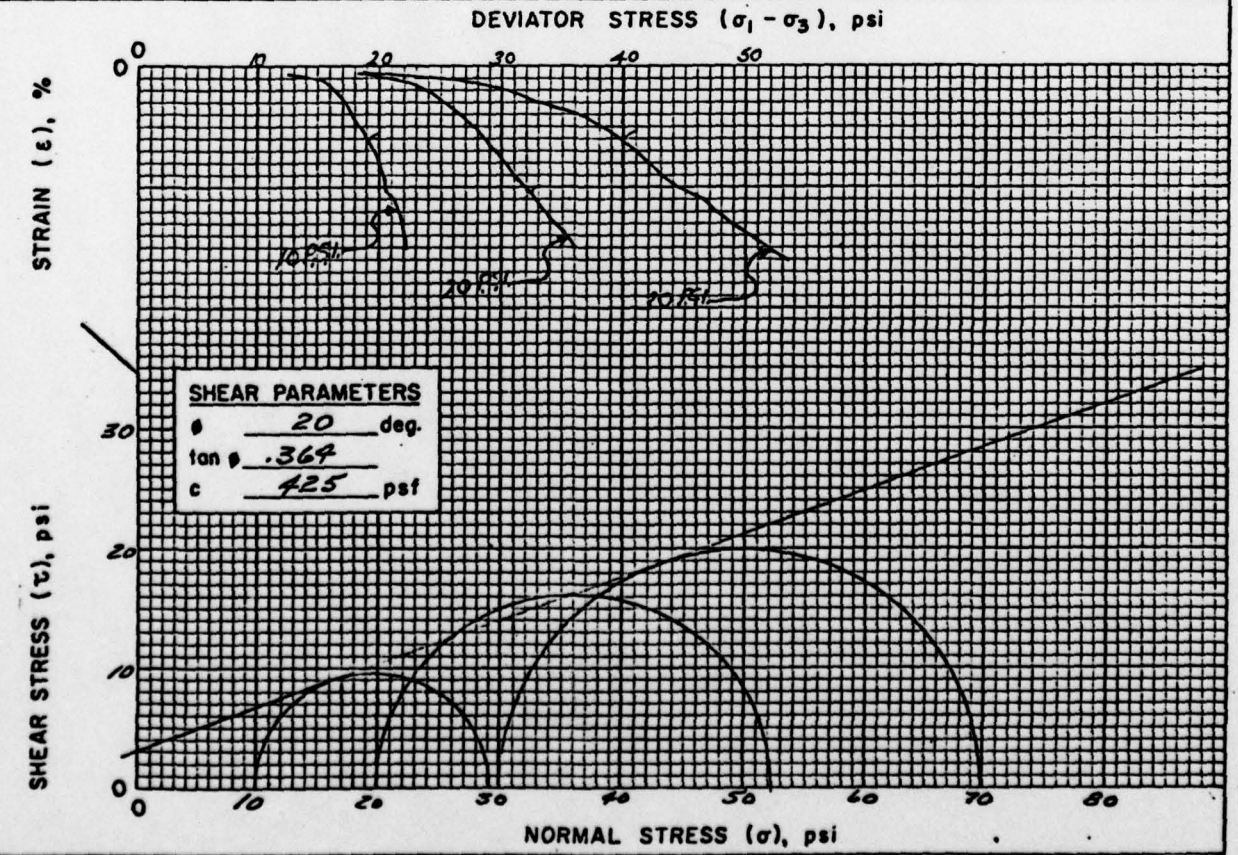
SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED #4 SIEVE
METHOD OF PREPARATION STATIC
COMPACTION 3 LIFTS
MOLDING MOISTURE 17.5 %
MOLDED AT 94.4% OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☑
CD ☐

DRY DENSITY INITIAL pcf ☒ g/cc ☐	DRY DENSITY CONSOLIDATED pcf ☒ g/cc ☐	B Parameter	MOISTURE CONTENT, % START OF TEST	MOISTURE CONTENT, % DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, % END OF TEST	TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
111.2	112.0	0.95	17.4		18.2	36.5	10	19.1	6.1
111.2	112.1	0.95	17.3		17.1	16.8	20	32.3	10.5
110.4	113.0	0.98	17.7		16.4	39.9	30	39.9	6.0



REMARKS: BACK PRESSURED TO SATURATE

GFH/

Form SCS 355B
6-65

LABORATORY NO 20116-23

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE: FURNACE BROOK SITE 2 NEW JERSEY

SAMPLE LOCATION: AUX. SPILLWAY 70'C. EQUA 26+15

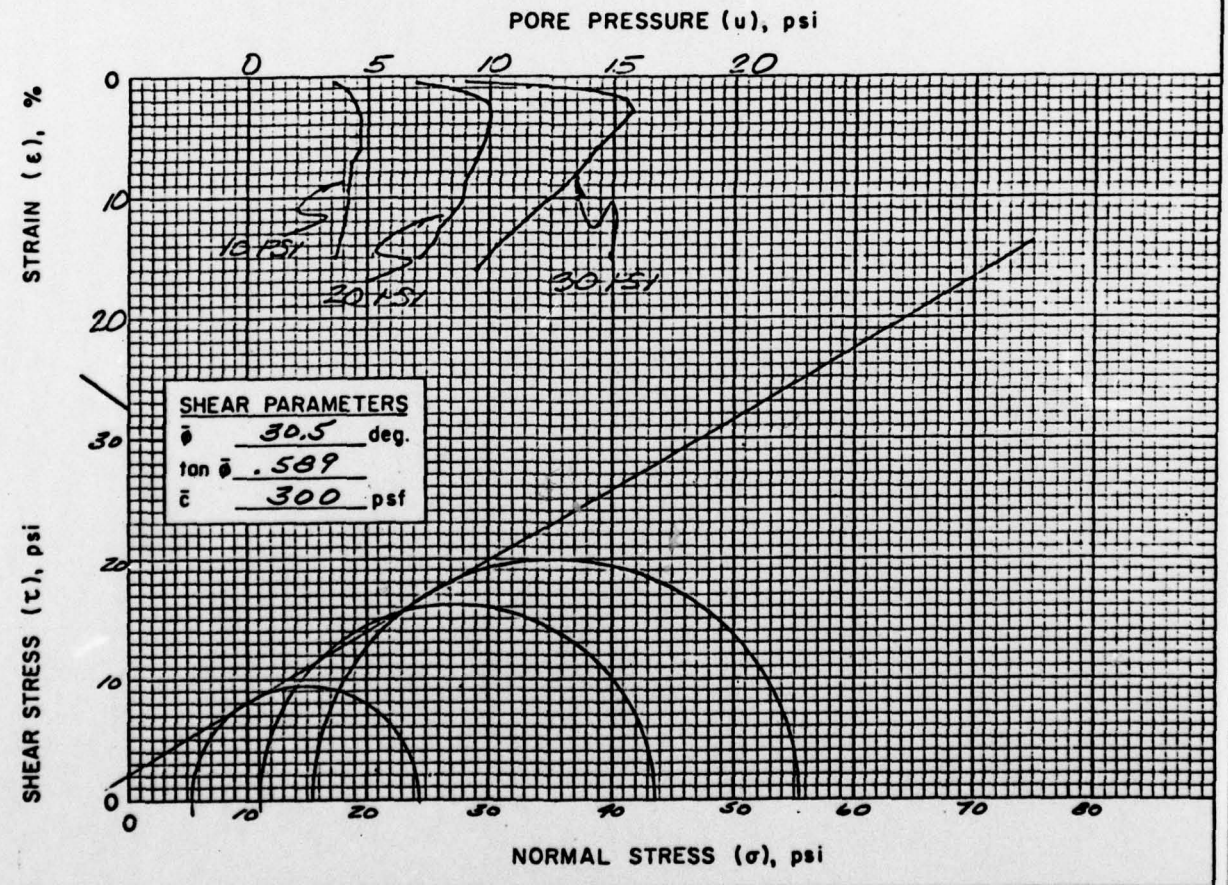
TYPE OF SAMPLE: COMPACTED

TESTED AT: SML-LINCOLN

APPROVED BY: LPD

DATE: 12-15-69

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ε (%)
10	4.6	5.4	19.1	$\frac{\bar{\sigma}_1}{\bar{\sigma}_3}$ max	6.1
20	8.8	11.2	32.3		10.5
30	14.4	15.6	39.9		6.0



REMARKS SACK PRESSURED TO SATURATE

GTH

Form SCS 352
Rev. 5-65

LABORATORY NO 70W690

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT and STATE: Furnace Brook, Site 2, New Jersey

FIELD SAMPLE NO.	LOCATION	DEPTH
6	Aux. Spillway, 630' Rt. & Dam 23+20.	580-572 2-8'

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN		

CLASSIFICATION CL LL 31 PI 11

MAX. PARTICLE SIZE INCLUDED IN TEST < #4 "

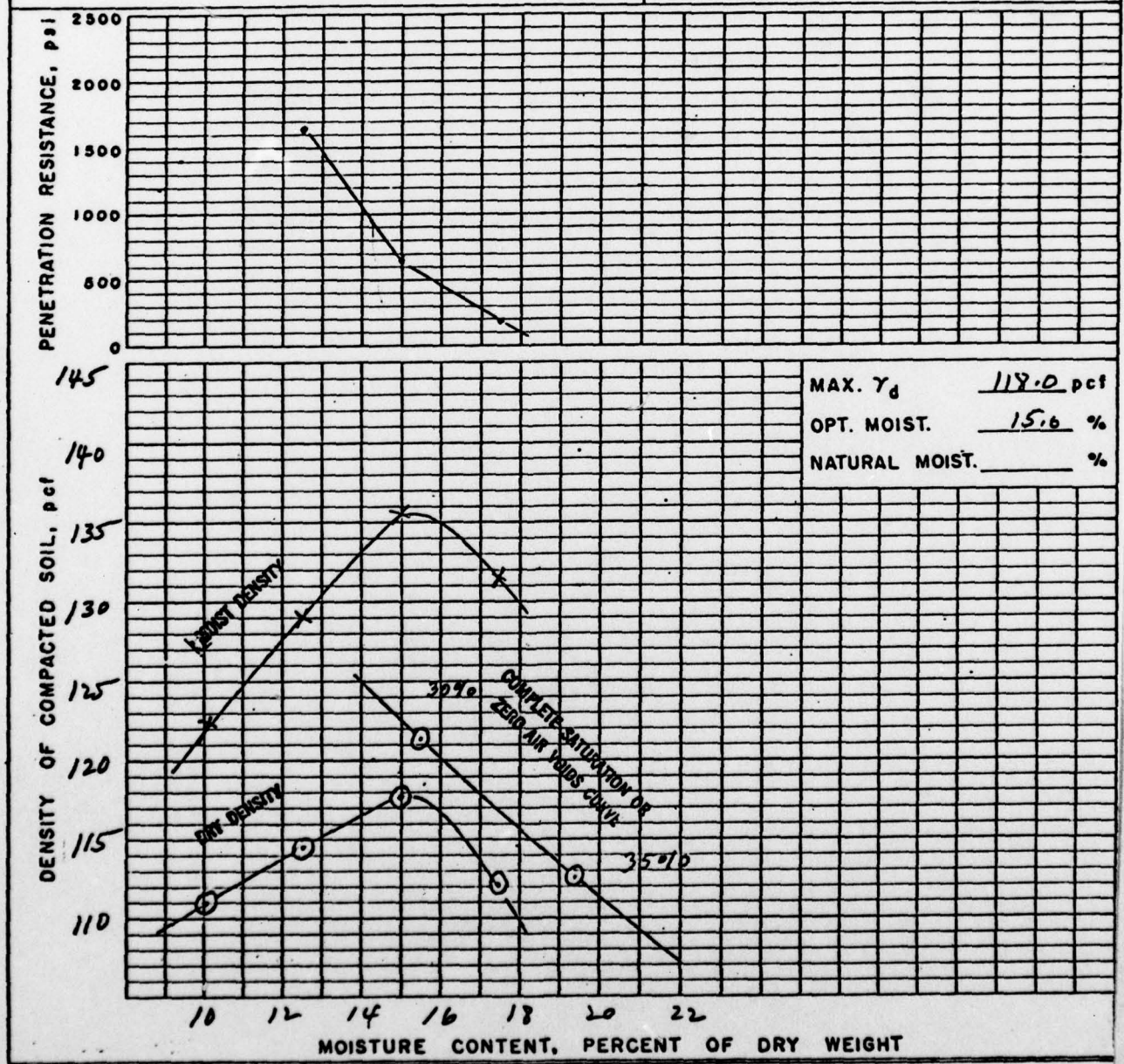
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.78 ; PLUS NO. 4 }

CURVE NO. 2 OF 2

STD. (ASTM D-698) ☒; METHOD A

MOD. (ASTM D-1557) ☐; METHOD

OTHER TEST ☐ (SEE REMARKS)



MAX. γ_d 118.0 pcf

OPT. MOIST. 15.6 %

NATURAL MOIST. ____ %

REMARKS

CURVE IS FOR THE MINUS NO. 4 FRACTION

GRADATION OF TOTAL SAMPLE

< NO. 200 52 %; < NO. 4 89 %; < 3 IN. 100 %

Form SCS 352
Rev 5-65

LABORATORY NO 704162

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANC

PROJECT and STATE: Furnace Brook, Site 2, New Jersey. 599.5-5

FIELD SAMPLE NO.	LOCATION	DEPTH
4	Aux. Spillway, 70' L & Dam 26+15.	2-10'.

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN		

CLASSIFICATION CL-ML LL 27 PI 7

MAX. PARTICLE SIZE INCLUDED IN TEST < #4 "

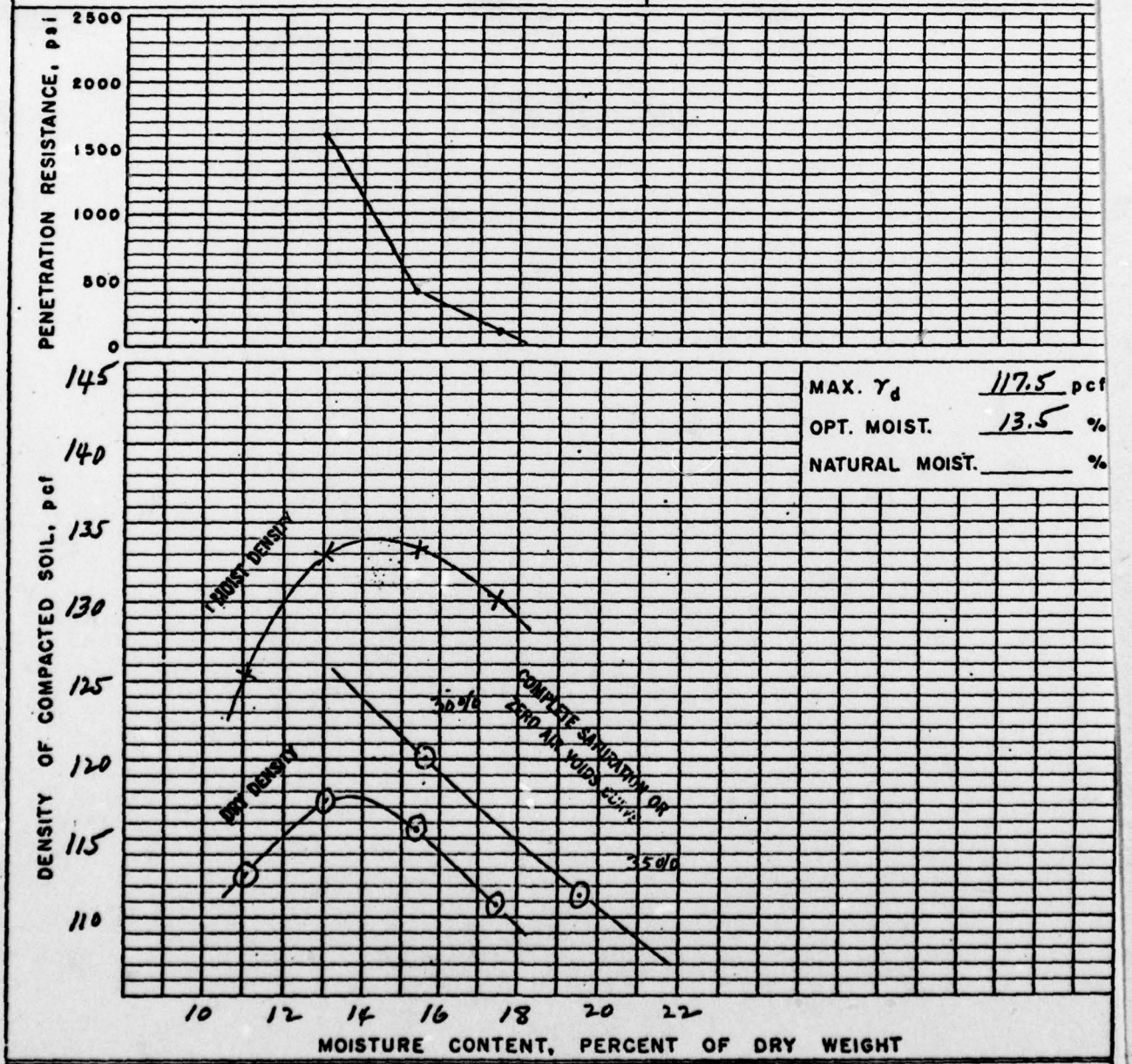
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.75 ; PLUS NO. 4 }

CURVE NO. 1 OF 2

STD. (ASTM D-698) ☒; METHOD A

MOD. (ASTM D-1557) ☐; METHOD

OTHER TEST ☐ (SEE REMARKS)



MAX. γ_d 117.5 pcf

OPT. MOIST. 13.5 %

NATURAL MOIST. ____ %

REMARKS

CURVE IS FOR THE MINUS NO. 4 FRACTION

GRADATION OF TOTAL SAMPLE

< NO. 200 51 %; < NO. 4 91 %; < 1½ IN. 100 %

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GPO 1958 O—470867

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT Foundation Permeability — SHEET 1 OF 6

Summary of Field Test Data

Material B - Young glacial Till

Test Hole	Soil Class	Depth	K fps	
1	SM - {Sand w/15% Silt	8'-10'	0	
		10'-12'	0	
	Cobbles, boulders gravel w/matrix of silty sand	20-25	5.4	Boulders & Cobbles
2	SM w/15-20% fines	15'-17'	0	
3	SM w/12-15% fines	10'-12'	0	
		15'-17'	0	
		20'-22'	0	
		25'-27'	3.5	(Possibly Mat'l E)
	GM - Cobbles, gravel boulders w/silty sand matrix	30-32'	4.3	(Possibly Mat'l E)
4	10'-12' cobbles & boulders	10-15	25	Boulders & Cobbles
12	SM - w/15-25% fines	11-13	0.1	
15	SC {Sand w/20-30% low plast. fines	11-13	0	
		16-18	0	
201	SC {Sand w/40-50% low plast. fines	11-13	0	
		16-18	0	
202	SC {Sand w/40-50% fines	11-13	0	
		16-18	0	
	CL	26-28	0	
601	SM Sand w/10-15% fines	16-18	0	
602	SM {Sand w/12-15% fines	10-12	0	
		15-17	0	

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTU.
SOIL CONSERVATION SERVICE

GPO 1956 O—67

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT Foundation Permeability — SHEET 2 OF 6

Summary of Field Test Data

Material C - Interglacial Fluvial

Test Hole	Soil Class	Depth	K fpd	
10	0-11' SW-SM (8-12% fines)	10-12	1.0	CL from 11'-1
11	SM-SP (5-12% fines	11-13	0.1	
11	8.6-17 (SM-SP) 17-31 (CL)	16-18	1.4	
13	SW-SM (10-15% silt)	11-13	0.2	
	SM - 12-15% fines	16-18	0.1	
		21-23	1.1	
	SP clean	26	6.3	
		26-28	1.8	

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1958 O—470857

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT Foundation Permeability — SHEET 3 OF 6

Summary of Field Test Data

Material D Lacustrine

Test Hole	Soil Class	Depth	K fpd
2	ML	25-27	0
6	SC w/20-30% fine	8-10	0
		10-12	0
7	ML	10-12	0
10	CL	15-17	0
11	CL	21-23	0
	"	26-28	0
	CL	31-33	0
	"	36-38	0
	"	38-40	0
12	CL	21-23	0
13	CL	36-38	0
		41-43	0
14	CL	11-13	0
	"	16-18	0
15	CL	36-38	0
	"	42-44	0
201	CL	21-23	0
301	ML	26-28	0
302	SC w/30-40% Clay	10-12	0
303	SC w/25-35% fine	11-13	0
	CL	16-18	0
304	ML	10-12	0
	SM w/12-15% fines	21-23	0
502	CL	13-15	0
	"	16-18	0.1
	"	21-23	0
	"	26-28	0
604	SC w/20-40% fines	10-12	0
605	CL	11-13	0
	"	16-18	0

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1958 O—470867

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT Foundation Permeability — SHEET 4 OF 6

Summary of Field Test Data

Material E - Interglacial Fluvial

Test Hole	Soil Class	Depth	k (fpd)	
2	SP-SM	30-32	10.3	
4	SM	20-22	18.8	
	31.5-37 - SP-SM 26-31.5 SM	31-33	12.1	
5	SM 12-15% fines	15-17	0	
	SW	21-23	0.2	
6	SM - 12-15% fines	20-22	0.1	
7	SM { w/12-20% fines	15-17	1.8	
	{	26-28	1.8	
	SP	36-38	73.4	} Water Bearing
	SP	41-42	113.8	} Water Bearing
	SP	46-48	10.0	
	CL	50-51.5	0	
8	CL	42-50	0	
9	Boulders & Cobbles	20-22	19.6	
	SP	22-24	18.0	
	SM	32-34	0.2	
10	21-24' (CL) 24-30 (SW-SM)	21-30	5.0	
	ML	35-37	0	(ML)
11	SW-SM (10-12% fines)	42-43	0.2	
		42-45	0.7	
		46-48	4.7	
		46-49.5	13.9	
	ML	51-53	0	(ML)
	"	53-55	0	(ML)
	"	51-60	0.1	(ML)
	SM	60-61	0.1	
13	GW-GM	51-52.5	18.1	
	"	55	7.8	
	"	55-60	2.8	
	"	60-65	2.4	
	GW-GM to 70' SM (70-72)	67-72	3.8	
301	SP	15-18	1.5	
	SP to 21.5' ML 21.5-29	21-23	30.4	
302	SM { SM w/12-20% { silt	15-18	0.4	
		25-27	0.2	
	SM w/20-30% fines	30-32	0.2	
	SP	35-37	6.6	

COMPUTATION SHEET

SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1958 O-431

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.
SUBJECT Foundation Permeability				SHEET 5 OF 6

Summary of Field Test Data
Material E - Interglacial Fluvial - (Con't)

Test Hole	Soil Class	Depth	K (Fpd)
303	SM w/12-20% fines	21-23'	0.2
		26-28	0
		32-34	0
		34-35.5	0.2
304	SM w/12-15% fines	15-17	17.3 !
Boulder at 26-27.5'	SP -	27.5-29.5	17.3
501	SM w/12-15% fines	10-12	1.2
		15-17	1.2
		21-23	0
502	SW-SM	31-33	0.7
	SW-SM	42.6-44.6	3.2
	"	48-50	2.4
603	SP	15-17	0.2
SP to 26.5	SM	25-27	0.2
604	SW-SM	16-18	7.5
	"	21-23	0
	"	26-27	0
605	SW-SM	26-28	0.2
	"	31-33	0
	ML	37-39	0
701	SP-SM	17-18.5	0.7
	SM	25-27	0
	SP-SM	30-32	0.7

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1958 O-470667

STATE New Jersey		PROJECT Furnace Brook		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT Foundation Permeability — SHEET 6 OF 6

Summary of Field Test Data

Material F Glacial Till

Test Hole	Soil Class	Depth	K (fpd)
3	GM Cobbles, gravel, boulders w/silty Sand Matrix	35-37	0
	"	35-40	0
	"	40-45	4.5
5	SM silty sand	36-38	0
7	SM Sand w/12-15% Fines	65-66	0.2
		68-68.4	0.1
11	SM Sand w/12-15% Fines	65-66.5	0.5
		71-72	1.1
15	SM Sand w/15-25% Fines	55-56.5	0
201	SC Sand w/40-50% low plastic fines	26-27	0
		34.5-36	0
301	SM w/Traces of Gravel & Cobbles	34-36	2.4
302	SM w/20-30% Fines	40-42	0.6
304	SM w/ 20-30% silt Hardpan	35-37	0
501	SM w/20-30% Fines	26-28	0
601	SM w/12-15% fines	26-28	0.4
		36-38	8.6
603	SM w/12-15% fines	30-31½	0
		35-37	0
604	SM w/25-35% fines	36-37	0
		46-46.5	0
605	SM w/15-25% fines	42-44	1.0
		53-54.6	0
		58-60	0.1

Form SCS 337
Rev. 6-63

U. S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

MATERIALS TESTING REPORT

SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE: FURNACE BROOK SITE #2 NEW JERSEY

METHOD OF ANALYSIS: SWEDISH CIRCLE

ANALYZED AT: SML LINCOLN NB

APPROVED BY:

DATE: 12-1-69

	SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA: γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg.)	tan ϕ	c (psf)	REMARKS
①	EMBANKMENT	CL-ML	110.9	125.0	130.0	67.5	30.5	.589	300	CU
②							20.0	.364	425	CU
③										
④										
⑤										
⑥										
⑦										
⑧										

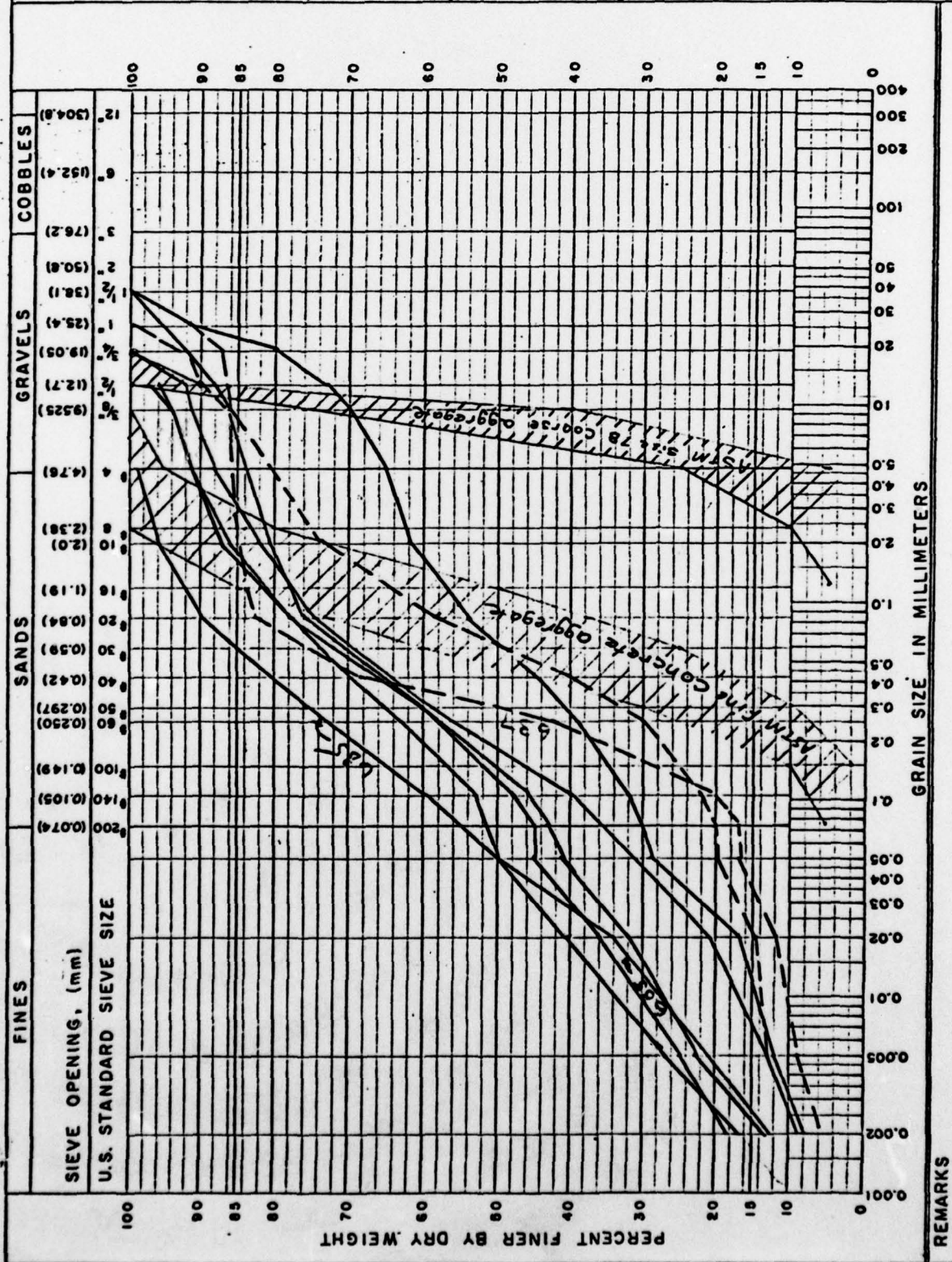
TRIAL NO.		SLOPE	MAXIMUM SECTION CONDITIONS @ STATION 9+90	F_s
1	UP	3:1	FULL DRAWDOWN - NO BERM - ARC CUT FROM OPPOSITE	
			SHOULDER THRU EMB. (20°-425) ONLY	1.44
1A	UP	3:1	FULL DRAWDOWN - NO BERM - ARC CUT FROM OPPOSITE	
			SHOULDER THRU EMB (30.5°-300) ONLY	1.70
2	UP	3:1	SAME CONDITIONS AS TRIAL #1	1.48
3	UP	3:1	SAME CONDITIONS AS TRIAL #1	1.45
4	DN	3:1	DRAIN @ γ_b = 0.6 - NO BERM - ARC CUT FROM OPPOSITE	
			SHOULDER THRU EMB. (20°-425) ONLY	1.88
5	DN	3:1	SAME CONDITIONS AS TRIAL #4	1.83
6	DN	3:1	SAME CONDITIONS AS TRIAL #4	1.88

Form SCS 130
5-65

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	DRAIN MATERIALS

PROJECT and STATE: Furnace Brook Site 2 New Jersey

DESIGNED AT	BY	DATE
JML Lincoln	LPD	12-4-69



REMARKS

FURNACE BROOK
LOGS OF DRILL HOLES
AND TEST PITS

TEST PIT 1, ℄ DAM STA 10+40, ELEV 563.2

0.0	1.0	Topsoil	
1.0	3.5	Clay, low plas., sandy, mottled	(CL)
3.5	12.0	Sand, silty, w/gravel, well graded w/15-20% fines, glacial till	(SM)

TEST PIT 2, 10' RIGHT, ℄ DAM STA 21+90, ELEV 588.6

0.0	0.5	Topsoil	
0.5	5.5	Sand, clayey, w/40-50% low plas. clay, fine to medium, low perm., glacial till	(SC)
5.5	7.5	Clay, low plas., low perm., mottled	(CL)
7.5	10.0	As 0.5 - 5.5 with scattered cobbles, glacial till	(SC)

TEST PIT 101, 515' LEFT, ℄ DAM STA 25+70, ELEV 581.4

0.0	0.5	Topsoil	
0.5	10.0	Glacial till as T-608	(SC)

TEST PIT 102, 290' LEFT, ℄ DAM STA 24+05, ELEV 582.6

0.0	0.5	Topsoil w/numerous cobbles, scattered boulders	
0.5	1.0	Silt, sandy, low plas., 20-40% sand, mottled, moist	(ML)
1.0	7.0	Glacial till as T-608	(SC)

TEST PIT 103, 170' LEFT, ℄ DAM STA 22+75, ELEV 585.0

0.0	1.0	Topsoil	
1.0	5.5	Glacial till as T-608	(SC)
5.5	7.5	Silt, gray, low plas.	(ML)
7.5	8.0	Glacial till as T-608 slight seepage @7.5	(SC)

TEST PIT 104, 70' LEFT, ℄ DAM STA 22+80, ELEV 585.4

0.0	0.5	Topsoil	
0.5	7.0	Sand, clayey w/40-60% low plas. clay, sand fine to medium w/traces coarse sand, very low perm., brown	(SC or CL)
7.0	12.0	Clay, sandy, w/10-20% fine to medium sand, traces of coarse sand, gravel and cobbles, dark gray	(CL)

TEST PIT 105, 90' LEFT, ℄ DAM STA 24+70, ELEV 589.8

0.0	0.5	Topsoil	
0.5	10.0	Sand, clayey, w/40-50% low plas. fines, sand fine to medium w/trace of cobbles, brown, low perm., slight seepage	(SC)

TEST PIT 106, 110' LEFT, ℄ DAM STA 26+45, ELEV 599.9

0.0	0.5	Topsoil	
0.5	12.0	Sand, clayey, w/40-50% low plas. fines, fine to medium, traces of gravel, moist, brown, glacial till	(SC)

TEST PIT 107, 130' LEFT, ℄ DAM STA 28+45, ELEV 608.9

0.0	0.5	Topsoil	
0.5	12.0	Glacial till as T-106 w/less moisture	(SC)

TEST PIT 108, 70' RIGHT, ℄ DAM STA 28+20, ELEV 611.1

0.0	0.5	Topsoil	
0.5	12.0	Sand, silty, with 40-50% low plas. fines, fine to medium, trace of gravel, moist, brown, glacial till	(SC)

TEST PIT 109, 70' RIGHT, ℄ DAM STA 26+15, ELEV 599.5

0.0	0.5	Topsoil	
0.5	12.0	Sand, clayey, w/40-50% fines, fine to medium, trace gravel and cobbles, moist, brown, glacial till	(SC)

TEST PIT 110, 70' RIGHT, ℄ DAM STA 24+30, ELEV 593.4

0.0	0.5	Topsoil	
0.5	10.0	Sand, clayey, w/40-50% low plas. fines, fine to medium, brown, moist, glacial till	(SC)

TEST PIT 111, 345' RIGHT, ℄ DAM STA 27+50, ELEV 605.6

0.0	1.0	Topsoil and boulders to 2.0, numerous cobbles	
1.0	12.0	Sand, clayey, w/40-50% low plas. clayey fines, sand fine to medium trace of gravel and cobbles, glacial till	(SC)

TEST PIT 112, 420' RIGHT, ℄ DAM STA 25+20, ELEV 594.4

0.0	0.5	Topsoil	
0.5	10.0	Sand, clayey, w/40-60%, low plas. fines, sand, fine to medium, cobbles and boulders from 0-2.5, glacial till	(SC) or (CL)

TEST PIT 113, 660' RIGHT, ℄ DAM STA 25+00, ELEV 590.3

0.0	0.5	Topsoil	
0.5	12.0	Sand, clayey, w/40-50% low plas. fines, sand fine to medium scattered cobbles, seeps from root zone, glacial till	(SC)

TEST PIT 114, 630' RIGHT, ℄ DAM STA 23+20, ELEV 582.1

0.0	0.5	Topsoil	
0.5	8.0	Sand, w/40-50% low plas. fines, fine to medium w/trace of gravel and cobbles, glacial till	(SC)

TEST PIT 115, 390' RIGHT, ℄ DAM STA 21+70, ELEV 580.0

0.0	0.5	Topsoil	
0.5	6.0	Sand, clayey, w/40-50% fines, scattered cobbles, fine to medium sand, boulders scattered @4' glacial till	(SC)

TEST PIT 116, 380' RIGHT, ℄ DAM STA 23+05, ELEV 585.0

0.0	0.5	Topsoil	
0.5	7.0	Sand, clayey, w/40-50% fines, sand fine to medium trace of cobbles and boulders, glacial till	(SC)

TEST PIT 601, 780' LEFT, ℄ DAM STA 10+60, ELEV 585.3

0.0	0.5	Topsoil, stonedrain	
0.5	4.5	Sand, silty, gravelly w/12-15% fines, well graded	(SM)
4.5	7.0	Gravel, sandy, w/40-50% sand, well graded 5-12% fines, trace cobbles and boulders, seepage @4½ rapid to 7' caving	(GW-GM)

TEST PIT 602, 765' LEFT, ℄ DAM STA 11+60, ELEV 580.4

0.0	4.0	Silt, low plastic w/trace organic, soft, gray	(ML)
4.0	8.0	Gravel, sandy, w/40-50% sand, w/5-10% silty fines, well graded, trace cobbles and boulders, seepage @7' fairly dense	(GW-GM)

TEST PIT 603, 675' LEFT, ℄ DAM STA 16+40, ELEV 556.3

0.0	0.5	Topsoil	
0.5	4.5	Sand, clayey, w/35-45% low plas. clay, sand medium to fine, poorly graded, orange, moist	(SC)
4.5	11.0	Gravel, sandy, w/8-12% silt, well graded to 8", 40-50% sand, moderate perm., wet, seepage @9' alluvium	(GW-GM)
11.0	12.0	Sand, clayey, w/20-30% fines, well graded, moderate perm.; glacial till	(SC)

TEST PIT 604, 660' LEFT, ℄ DAM STA 17+60, ELEV 558.2

0.0	0.5	Topsoil	
0.5	9.0	Sand, clayey, w/40-50% low plas. fines, brown, well-graded	(SC)
9.0	9.5	Sand, w/8-12% fines, well graded, w/trace gravel seepage @ 1-2 gpm	(SW-SM)
9.5	12.0	Clay, firm, moist, low plas., very low perm.	(CL)

TEST PIT 605, 635' LEFT, ℄ DAM STA 18+55, ELEV 559.7

0.0	0.5	Topsoil	
0.5	11.0	Sand, clayey, w/40-50% fines, well graded, sand, glacial till	(SC)
11.0	12.0	Clay, low plas., brown	(CL)

TEST PIT 606, 610' LEFT, ℄ DAM STA 19+50, ELEV 564.5

0.0	0.5	Topsoil	
0.5	12.0	Glacial till as T-605	(SC)

TEST PIT 607, 595' LEFT, ℄ DAM STA 20+65, ELEV 563.6

As Test Pit 606

TEST PIT 608, 590' LEFT, ℄ DAM STA 12+55, ELEV 564.5

0.0	0.5	Topsoil	
0.5	5.0	Silt, sandy, low to mod. plas. w/10-20% fine sand, mottled gray, orange-brown	(ML)
5.0	9.0	Sand, clayey, w/40-50% low plas. fines, fine to med. sand, trace gravel, low perm., glacial till	(SC)

TEST PIT 609, 560' LEFT, ℄ DAM STA 22+60, ELEV 571.3

0.0	0.5	Topsoil	
0.5	12.0	Glacial till as T-608	

TEST PIT 610, 540' LEFT, ℄ DAM STA 23+80, ELEV 576.7

0.0	0.5	Topsoil	
0.5	10.0	Glacial till as T-608	
10.0	12.0	Clay, gray, w/5-10% sand and gravel, low plas., low perm.	(CL)

TEST PIT 611, 360' LEFT, ℄ DAM STA 21+65, ELEV 574.3

0.0	0.5	Topsoil	
0.5	7.0	Sand, clayey, w/40-50% low plas. fines, fine to medium sand, trace gravel, scattered cobbles and boulders to 2', low perm.	(SC)

TEST PIT 612, 315' LEFT, ℄ DAM STA 17+50, ELEV 575.1

0.0	0.5	Topsoil	
0.5	8.0	Glacial till, as T-611 w/5-10% cobbles and scattered boulders, brown, low perm.	(SC)

TEST PIT 613, 500' LEFT, ℄ DAM STA 15+95, ELEV 556.8

0.0	0.5	Topsoil	
0.5	9.0	Sand, clayey, w/40-50% low plas. fines, sand well graded, trace gravel, dense, glacial till	(SC)
9.0	11.5	Gravel, sandy, w/30-40% well graded sand, 10% cobbles, 8-12% fines, wet, slight seepage	(GW-GM)
11.5	12.0	Clay dense, low plas., brown, low perm.	(CL)

TEST PIT 614, 480' LEFT, ℄ DAM STA 15+10, ELEV 555.9

0.0	0.5	Topsoil	
0.5	1.5	Sand, silty, w/30-40% clayey fines	(SC)
1.5	6.0	Sand, gravelly, silty, w/20-30% gravel, 12-15% low plas. fines, well graded, slight seepage @5'	(SM)
6.0	8.0	Clay, low plas., brown, firm, moist, very low perm.	(CL)

TEST PIT 615, 445' LEFT, ℄ DAM STA 14+20, ELEV 554.6

0.0	0.5	Topsoil	
0.5	2.0	Sand, gravelly, w/12-20% clay, cobbles	(SC)
2.0	7.0	Gravel, sandy, silty w/40-50% sand, 8-12% fines, all well graded, moist, cobbles to 15", low perm., slight seepage @6'	(GW-GM)
7.0	8.0	Clay, firm, moist, low perm.	(CL)

TEST PIT 616, 340' LEFT ℄ DAM STA 15+05, ELEV. 556.8

0.0	0.5	Topsoil	
0.5	6.0	Sand, clayey, w/35-45% low plas. clayey fines, well graded, dense, low perm., brown, glacial till	(SC)
6.0	9.0	Clay, firm, low plas., very low perm., brown	(CL)

TEST PIT 617, 365' LEFT, ℄ DAM STA 14+05, ELEV 554.3

0.0	0.5	Topsoil	
0.5	4.0	Sand, clayey, w/35-45% fines, well graded, brown, low perm.	(SC)
4.0	5.5	Sand, gravelly, w/8-12% fines, well graded, seepage	(SW-SM)
5.5	9.0	Clay, firm, moist, low plas., low perm., brown	(CL)

TEST PIT 618, 355' LEFT, ℄ DAM STA 13+45, ELEV 551.0

0.0	0.5	Topsoil	
0.5	3.0	Gravel, sandy, w/cobbles, silt, 40-50% sand, 8-12% fines, all well graded	(GW-GM)
3.0	6.5	Sand, silty, w/8-12% fines, well graded, seepage general	(SW-SM)
6.5	10.0	Sand, clayey, w/15-25% low plas. fines, poorly graded, medium sd., low perm., trace of fine gravel	(SC)
10.0	12.0	Sand, clayey, w/30-40% clay, well graded, low perm.	(SC)

TEST PIT 619, 215' LEFT, ℄ DAM STA 14+65, ELEV 551.5

0.0	2.0	Topsoil	
0.5	7.0	Sand, clayey, w/35-45% low plas., fines, well graded, sand, brown, low perm., w/small isolated sand pockets, glacial till	(SC)
7.0	12.0	Clay, low plas., firm, moist, very low perm., gray	(CL)

TEST PIT 620, 190' LEFT, ℄ DAM STA 13+40, ELEV 548.6

0.0	0.5	Topsoil	
0.5	6.0	Gravel, sandy, w/40-50% well graded sand w/8-12% silty fine.	(GW-GM)
6.0	9.0	Clay, low plas., firm, moist, gray.	(CL)

TEST PIT 621, 380' LEFT, ℄ DAM STA 10+75, ELEV 559.4

0.0	0.5	Topsoil	
0.5	2.5	Sand, silty, w/12-15% fines, fine to medium, trace clay	(SM)
2.5	7.5	Sand, medium to coarse w/10-20% fine sand, angular, seepage @5'	(SP)
7.5	8.0	Gravel, permeable, w/cobbles, rapid seepage	(GW)

TEST PIT 622, 140' LEFT, ℄ DAM STA 5+85, ELEV 566.9

0.0	0.5	Topsoil	
0.5	3.0	Sand, silty, w/20-30% fines, sand fine to medium	(SM)
3.0	8.0	Sand, silty, w/12-20% fines, well-graded with trace gravel, seepage @6', glacial till	(SM)

TEST PIT 623, 250' LEFT, ℄ DAM STA 10+05, ELEV 563.1

0.0	0.5	Topsoil	
0.5	3.0	Sand, silty, w/30-40% fines, sand fine to medium	(SM)
3.0	11.0	Sand, silty, w/12-15% fines, sand well graded, dense, seepage slight below 5', glacial till	(SM)

TEST PIT 624 , 70' LEFT, ℄ DAM STA 6+90, ELEV 571.3

0.0	1.0	Topsoil	
1.0	12.0	Sand, silty w/12-20% silty fines, trace of gravel and cobbles, well graded, dense, low perm., seepage @ 11', glacial till	(SM) (SM)

TEST PIT 625, 80' LEFT ℄, DAM STA 8+10, ELEV 566.2

0.0	1.0	Topsoil	
1.0	4.0	Sand, gravelly, cobbles, boulders, well graded w/5-10% fines	(SW-SM)
4.0	8.5	Sand, medium to coarse w/3-5% fines, trace gravel, seepage @ 6'	(SP)

TEST PIT 626, 40' LEFT, ℄ DAM STA 9+90, ELEV 563.9

0.0	1.0	Topsoil	
1.0	5.5	Sand, silty, w/15-20% fines, well graded, trace cobbles and boulders	(SM)
5.5	7.5	Sand, gravelly, w/ 5-10% fines, well graded, seepage @ 6'	(SW-SM)
7.5	11.0	Sand, silty, w/12-15% fines, well graded	(SM)

TEST PIT 627, 70' RIGHT, ℄ DAM STA 10+90, ELEV 559.4

0.0	0.5	Topsoil	
0.5	10.0	Sand, silty, trace of clay, w/15-20% low plas. fines, well graded, trace of gravel, dense, glacial till	(SM)

TEST PIT 628, 40' LEFT, ℄ DAM STA 11+00, ELEV 552.5

0.0	1.0	Topsoil	
1.0	3.5	Sand, silty, w/30-40% fines, low perm., mottled	(SM)
3.5	9.0	Sand, silty, w/12-18% fines, well graded, gravelly, w/scattered sand and gravel lenses, seepage @ 6' (rapid)	(SM)

FURNACE BROOK
LOGS OF DRILL HOLES
AND TEST PITS

				Standard Penetration Depth	Blows/foot
DRILL HOLE 1, 10 LEFT, ℄ DAM STA 7+70, ELEV 577.6					
0.0	1.0	Topsoil		0.5 - 1.5	6
1.0	20.0	Sand, silty, w/15% low plastic silt, well graded, angular, trace of gravel, glacial till	(SM)	2.5 - 3.5	20
				4.5 - 5.5	52
				6.5 - 7.5	58
				8.5 - 9.5	92
				10.5 - 11.5	128
				15.5 - 16.5	52
20.0	28.0	Cobbles, boulders, gravel, with matrix of silty sand, mod. perm.		20.5 -	R
28.0	47.0	Gneiss, fractured, weathered		27.0 - 28.0	92
DRILL HOLE 2, 30' RIGHT, ℄ DAM STA 9+35, ELEV 575.2					
0.0	1.0	Topsoil		0.5 - 1.5	13
1.0	20.0	Sand, silty, well graded, w/15-20% silty fines, low perm. - till	(SM)	2.5 - 3.5	27
				4.5 - 5.5	52
				6.5 - 7.5	52
				8.5 - 9.5	58
				10.5 - 11.5	37
				15.5 - 16.5	33
20.0	27.0	Silt, sandy, w/30-40% well-graded sand low plastic, till	(ML)	20.5 - 21.5	22
				25.5 - 26.5	40
27.0	30.0	Sand, clean, w/40% fine, 50% medium, permeable	(SP)	30.5 - 31.5	54
30.0	35.0	Sand, w/8-12% silty fines, fine to medium	(SP-SM)		
35.0	36.5	Sand, silty, 40% fine, 40% medium, 20% coarse, trace gravel, w/15-20% silty fines	(SM)	35.5 - 36.5	53
36.5	49.0	Sand, silty, fine to medium, w/>12% fines, gneiss residual, slowly permeable	(SM)	41.5 - 42.5	89
DRILL HOLE 3, 10' LEFT, ℄ DAM STA 10+40, ELEV 562.0					
0.0	1.0	Topsoil		0.5 - 1.5	7
1.0	30.0	Sand, silty, well-graded, w/12-15% low plastic silty fines, low perm., till	(SM)	2.5 - 3.5	23
				4.5 - 5.5	52
				10.5 - 11.5	34
				15.5 - 16.5	100
				20.5 - 21.5	83
				25.5 - 26.5	108
30.0	45.0	Cobbles, gravel, boulders, with silty sand matrix, low perm., till	(GM)	30.5 - 31.5	50
				35.5 - 36.5	92
				37.5 - 38.5	130
45.0	50.0	Boulders and decomposed rock in silty sand matrix, low perm.	(GM)		

				Standard Penetration Depth	Blows/foo
DRILL HOLE 4, ℄ DAM STA 11+25, ELEV 555.4					
0.0	6.0	Topsoil		0.5 - 1.5	7
				2.5 - 3.5	49
				4.5 - 5.5	45
6.0	10.0	Sand, silty, well-graded, 12-15% low plastic silt, glacial till	(SM)	6.5 - 7.5	116
10.0	12.0	Cobbles and boulders			
12.0	20.0	Sand, silty well-graded, 12-15% low plastic silt, glacial till	(SM)	12.5 -13.5	90
				16.5 -17.5	69
20.0	26.0	Sand, silty, w/15%-25% silt, sand fine, poorly graded, poor stratification, low perm. except locally	(SM)	21.5 -22.5	31
				23.0 -24.5	66
26.0	31.5	Sand, micaceous, w/15-25% silt, sand fine, poorly graded	(SM)	26.5 -27.5	51
31.5	37.0	Sand, silty, well-graded, fine to coarse, w/trace gravel, w/10-20% low plas. fines, moderate perm.	(SP-SM)	32.0 -33.0	56
				36.0 -37.0	52
DRILL HOLE 5, ℄ DAM STA 11+95, ELEV 547.3					
0.0	4.0	Sand, silty, fine, poorly graded sand, gray, soft alluvium	(SM)	0.5 - 1.5	0
				2.5 - 3.5	4
4.0	8.0	Sand, well-graded w/trace gravel, w/5-10% fines, gray brown	(SP-SM)	4.5 - 5.5	22
				6.5 - 7.5	65
8.0	10.0	Sand, silty, well-graded, w/15-25% silty fines, alluvium	(SM)	8.5 - 9.5	80
10.0	15.0	Sand, silty, w/gravel, well-graded fine to coarse, w/12-15% fines, soft, alluvium	(SM)	10.5 -11.5	14
15.0	20.0	Sand, fine 12-15%, silt, poorly graded, orange, low perm.	(SM)	15.5 -16.5	45
20.0	21.0	Boulder			
21.0	36.0	Sand, fine to coarse, well-graded, permeable, alluvium	(SW)	21.5 -22.5	39
				26.5 -27.5	51
				31.5 -32.5	-
36.0	38.5	Sand, silty, well-graded, w/15-20% fines, low perm., glacial till	(SM)	37.0 -38.0	137
38.5	39.5	Boulder			
39.5	44.0	Sand, silty, well-graded, w/15-20% fines, low perm., glacial till		41.5 -42.5	117

				Standard Penetration Depth	Blows/foot
DRILL HOLE 6, ℄ DAM STA 12+60, ELEV 545.9					
0.0	2.0	Silt, organic, low plastic, gray brown	(ML)	0.5 - 1.5	6
2.0	21.0	Sand, clayey, med. to fine w/trace of coarse and trace gravel, gray, w/20-30% fines	(SC)	2.5 - 3.5	38
				4.0 - 5.0	16
				5.5 - 6.5	18
				7.0 - 8.0	9
				8.5 - 9.5	19
				10.5 - 11.5	22
				12.5 - 13.5	40
				15.5 - 16.5	34
				20.5 - 21.5	29
21.0	22.0	Sand, fine to med., poorly graded, w/12-15% fines, orange, alluvium	(SM)		
22.0	37.0	Sand, silty, w/12-20% silty fines, well-graded fine to coarse sand, glacial till	(SM)	25.5 - 26.5	95
				30.5 - 31.5	71
				35.5 - 36.5	87
DRILL HOLE 7, ℄ DAM STA 13+30, ELEV 544.9					
0.0	6.0	Sand, well graded, w/trace of gravel, 5-10% fines, some cobbles and boulders	(SW-SM)	0.5 - 1.5	45
6.0	11.0	Silt, gray, w/traces of clay, moist, low to med. plastic	(ML)	6.5 - 7.5	30
				10.5 - 11.5	43
11.0	15.0	Silt, brown, w/traces of clay, moist, low to med. plastic	(ML)		
15.0	35.0	Sand, silty, w/12-20% low plastic fines, sand well-graded, low perm., brown	(SM)	15.5 - 16.5	39
				20.5 - 21.5	76
				26.5 - 27.5	104
				31.5 - 32.5	86
35.0	46.0	Sand, med. to coarse, clean, permeable, water bearing	(SP)	36.5 - 37.5	133
46.0	50.0	Sand and gravel, sand med. to coarse, clean, permeable, water bearing	(SP)	46.5 - 47.5	16
50.0	60.0	Clay, low to moderate plasticity, moist, brown, 25% moisture	(CL)	50.5 - 51.5	166
				55.5 56.5	140
60.0	75.6	Sand, silt and cobbles, gravel, sand well-graded, w/12-15% fines (silty) low perm., brown-gray, glacial till	(SM)	60.5 61.5	134
				75.0 75.5	50

				Standard Penetration Depth	Blows/foot
DRILL HOLE 8, ℄ DAM STA 13+70, ELEV 544.1					
0.0	6.0	Sand, well graded w/trace gravel and 5-10% fines, orange-brown, wet	(SW-SM)	0.5 - 1.5	7
				2.5 - 3.5	135
				4.5 - 5.5	44
6.0	11.0	Silt, low to moderate plasticity, moist, brown	(ML)	6.5 - 7.5	27
11.0	13.0	Sand, clayey, w/30-40% low plastic clay, sand well-graded, trace fine gravel, grayish brown	(SC)	11.5 - 12.5	86
13.0	19.0	Clay, moderate plasticity, trace of sand and silt, gray	(CL)	16.5 - 17.5	62
19.0	19.9	Boulder			
19.9	29.8	Sand, silty, well-graded, trace gravel, w/10-12% fines	(SW-SM)	21.5 - 22.5	106
				26.5 - 27.5	63
29.8	31.0	Boulder			
31.0	36.0	Sand, clean, med., poorly graded, gravel	(SP)		
36.0	38.0	Clay, low to moderate plasticity, brown	(CL)	36.5 - 37.5	85
38.0	40.0	Boulder			
40.0	50.0	Clay, low to moderate plasticity, brown, moist	(CL)	40.5 - 41.5	81
				42.5 - 43.5	64
				44.5 - 45.5	52*
				46.5 - 47.5	35*
				48.5 - 49.5	27*
DRILL HOLE 9, ℄ DAM STA 14+20, ELEV 541.8					
0.0	0.5	Topsoil, silty sand, brown	(SM)		
0.5	3.5	Sand, silty, w/12-15% low plastic silt, sand fine to med., low plas. trace gravel, moist, brown	(SM)	0.5 - 1.5	3
				2.5 - 3.5	21
3.5	12.0	Silt, low plastic, w/traces of clay, sand and gravel, brown low perm.	(ML)	4.5 - 5.5	30
				6.5 - 7.5	42
12.0	19.0	Sand, clayey, w/20-30% low plastic clay, sand well graded, grayish-brown	(SC)	16.0 - 17.0	33*
19.0	20.5	Sand, clean, well graded, permeable	(SW)		
20.5	22.0	Boulder, cobbles			
22.0	23.5	Sand, clean, med. to coarse, gravelly, permeable	(SP)	22.5 - 23.5	46
23.5	30.0	Sand, silty, w/30-40% low plastic fines, sand well graded, trace gravel, moist, brown	(SM)	27.5 - 28.5	39
30.0	37.0	Sand, silty, w/12-15% fines, sand well graded, trace gravel, wet	(SM)	32.5 - 33.5	94
37.0	50.0	Sand, w/30-40% low plastic fines, well graded, dense boulders 44-48 feet, glacial till	(SM)	37.5 - 38.5	115
				42.5 - 43.5	41
				48.5 - 49.5	110

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 10, ℄ DAM STA 15+20, ELEV 551.2					
0.0	11.0	Sand w/8-12% fines, well-graded, angular gravel, silty fines	(SW-SM)	0.5 - 1.5	19
				2.5 - 3.5	84
				4.5 - 5.5	26
				6.5 - 7.5	13
11.0	15.0	Clay, low to moderate plasticity, silty, brown, moist	(CL)	10.5 - 11.5	92
15.0	21.0	Clay, low to moderate plasticity, silty, gray, moist.	(CL)	15.5 - 16.5	44
21.0	24.0	Clay, low to moderate plasticity, silty, brown, moist	(CL)	21.5 - 22.5	47
24.0	30.0	Sand, w/8-12% silty fines, well graded, gravelly	(SW-SM)	26.5 - 27.5	86
				28.5 - 29.5	149
30.0	37.0	Silt, low plastic, brown, moist	(ML)	33.5 - 34.5	60
				35.5 - 36.5	113
37.0	4[illegible]	Silt, low plastic, brown, sandy, sand-fine 5-15%, moist	(ML)	37.5 - 38.5	61*
DRILL HOLE 11, ℄ DAM STA 15+75, ELEV 571.7					
0.0	8.6	Sand, silty, damp, brown, w/15-20% fines, well graded gravelly, glacial till	(SM)	0.5 - 1.5	18
				2.5 - 3.5	45
				4.5 - 5.5	56
				6.5 - 7.5	100
8.6	17.0	Sand, moist, brown, silty, w/5-12% fines, fine to med.	(SM-SP)	11.5 - 12.5	40
				16.5 - 17.5	36
17.0	31.0	Clay, moist, brown, moderate plastic	(CL)	21.5 - 22.5	34
				26.5 - 27.5	48
31.0	40.0	Clay, moist, gray, moderate plastic	(CL)	31.5 - 32.5	53
				36.5 - 37.5	39
				38.5 - 39.5	62
40.0	49.6	Sand, moist, w/10-12% low plastic fines, well-graded, gravel, cobbles, boulders, low perm., dense	(SW-SM)	42.5 - 43.0	85
				48.5 - 49.5	76
49.6	60.0	Silt, brown, low plasticity, moist	(ML)	54.0 - 54.5	50*
60.0	63.0	Sand, silty, w/12-15% low plas. silt, low perm., sand-fine, poorly graded	(SM)	60.5 - 61.0	77*
63.0	72.0	Sand, moist, brown, w/12-15% fines, silty, gravel, cobbles, small boulders, glacial till	(SM)	65.5 - 66.0	40*
				71.5 - 72.0	35*
DRILL HOLE 12, ℄ DAM STA 17+00, ELEV 576.1					
0.0	1.0	Topsoil		0.5 - 1.5	5
1.0	16.0	Sand, silty, w/15-25% fines, some gravel, brown, moist	(SM)	2.5 - 3.5	35
				4.5 - 5.5	29
				6.5 - 7.5	31
				11.5 - 12.5	28
16.0	23.0	Clay, moist, gray, low plastic	(CL)	16.5 - 17.5	39
				21.5 - 22.5	36

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 13, ℄ DAM STA 18+00, ELEV 579.4					
0.0	1.0	Topsoil		0.5 - 1.5	9
1.0	11.0	Sand, silty w/20-25% fines, silty, gravelly	(SM)	2.5 - 3.5	43
				4.5 - 5.5	29
				6.5 - 7.5	92
11.0	16.0	Sand, well-graded, brown, 10-15% silt, little gravel	(SW-SM)	11.5 - 12.5	45
16.0	23.0	Sand, well-graded, 12-15% fines, silty, gravelly, w/silt lenses	(SM)	16.5 - 17.5	38
				21.5 - 22.5	19
23.0	35.0	Sand, clean, fine to medium, lenses of silt; poorly graded	(SP)	26.5 - 27.5	24
				31.5 - 32.5	11
35.0	45.0	Clay, moist, brown, low plastic	(CL)	36.5 - 37.5	53
				41.5 - 42.5	51
45.0	51.0	Clay, moist, gray, low plastic	(CL)	46.5 - 47.5	R
51.0	70.0	Gravel & sand, 10-12% fines, silty, cobbles, sand well-graded, 50-60% gravel	(GW-GM)	51.5 - 52.5	88*
				55.5 - 56.5	58
				60.5 - 61.5	R
				65.0 - 66.5	R
70.0	72.0	Sand, silty, w/15-25% fines, some gravel, well graded, dense, orange-brown glacial till	(SM)	70.5 - 71.5	46*
DRILL HOLE 14, ℄ DAM STA 19+00, ELEV 579.5					
0.0	0.6	Topsoil			
0.6	5.0	Silt, low plas., traces of sand & clay	(ML)	0.5 - 1.5	11
				2.5 - 3.5	26
				4.5 - 5.5	40
5.0	10.0	Sand, very fine, silty, w/10-12% fines, moist, brown, low perm..	(SP-SM)	6.5 - 7.5	46
10.0	18.0	Clay, low plas., brown to gray brown	(CL)	11.5 - 12.5	43
				16.5 - 17.5	48
DRILL HOLE 15, ℄ DAM STA 20+10, ELEV 582.0					
0.0	0.6	Topsoil			
0.6	2.0	Silt, sandy, w/trace gravel & clay, 20-30% sand, moist brown	(ML)	0.5 - 1.5	9
2.0	4.0	Sand, silty, w/20-30% low plas. fines, sand well-graded, trace gravel, brown, low perm.	(SM)	2.5 - 3.5	46
4.0	8.0	Sand, clayey, w/20-30% low plas. fines, well-graded sand, trace gravel, brown, low perm.	(SC)	4.5 - 5.5	45
				6.5 - 7.5	99
8.0	18.0	Sand, clayey, w/20-30% low plas. fines, well-graded sand, trace gravel, gray-brown, low perm.	(SC)	11.5 - 12.5	45
				16.5 - 17.5	43
18.0	28.0	Sand, clayey, w/20-30% low plas. fines, well-graded sand, trace gravel, gray, low perm.	(SC)	21.5 - 22.5	63
				26.5 - 27.5	55
28.0	45.0	Clay, low plas., gray	(CL)	31.5 - 32.5	45
				36.5 - 37.5	62
				42.5 - 43.5	70
45.0	50.0	Boulders & cobbles			
50.0	56.6	Sand, silty, w/15-25% fines, brown, trace gravel, low perm.	(SM)	50.5 - 51.5	27*
				55.5 - 56.5	30*

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 201, 50" RIGHT, ℄ DAM STA 25+05, ELEV 592.7					
0.0	0.5	Topsoil			
0.5	19.0	Sand, clayey, w/40-50%, low plas. fines sand fine to med. dense, brown glacial till	(SC)	0.5 - 1.5	12
				2.5 - 3.5	56
				4.5 - 5.5	73
				6.5 - 7.5	77
				11.5 - 12.5	51
				16.5 - 17.5	64
19.0	25.5	Clay, low plastic, gray	(CL)	21.5 - 22.5	47
25.5	36.0	Sand, clayey, w/40-50% low plastic clay, fine to med, dense, brown, glacial till	(SC)	26.5 - 27.5	R
				31.5 - 32.5	112
				35.0 - 36.0	56*
DRILL HOLE 202, 315' RIGHT, ℄ DAM STA 24+30, ELEV 592.0					
0.0	0.6	Topsoil			
0.6	2.0	Silt, sandy, brown, low plastic, sand poorly-graded	(SM-SP)	0.5 - 1.5	6
2.0	11.0	Sand, clayey, w/40-50% fines, brown, trace gravel, fine to med. glacial till	(SC)	2.5 - 3.5	38
				4.5 - 5.5	29
				6.5 - 7.5	15
11.0	27.0	Sand, clayey, w/40-50% fines, gray, trace gravel, fine to med., glacial till	(SC)	11.5 - 12.5	45
				16.5 - 17.5	75
				21.5 - 22.5	62
				26.5 - 27.5	39*
27.0	28.0	Clay, low plastic, gray	(CL)		
DRILL HOLE 301, 75" LEFT, ℄ DAM STA 14+70, ELEV 541.5					
0.0	2.0	Silt, sandy, w/trace organic, dark gray	(ML)	0.5 - 1.5	0
2.0	4.0	Sand, silty, w/5-10% silt, sand well-graded soft, gray	(SW-SM)	2.5 - 3.5	12
4.0	15.0	Silt, sandy, w/15-30% fine to med. sand, low to moderate plastic, gray, dense moist, cobble @11'	(ML)	4.5 - 5.5	42
				6.5 - 7.5	57
				11.5 - 12.5	154
15.0	21.5	Sand, clean, fine to med. water-bearing	(SP)	15.5 - 16.5	93
21.5	29.0	Silt, low plas., w/traces of fine sand, brown	(ML)	21.5 - 22.5	43
				26.5 - 27.5	48
29.0	30.5	Sand, silty, w/15-20% silt, sand well-graded, cobbles, boulders, low perm. till	(SM)		
30.5	34.0	Boulder			
34.0	44.0	As 29-30.5 w/trace of gravel & cobbles	(SM)	34.5 - 35.5	38
				40.5 - 41.5	131
44.0	50.0	Silt, sandy w/10-15% sand, low plas., dense, brown	(ML)	45.5 - 46.5	156
				47.5 - 48.5	81*

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 302, ℄ DAM STA 14+60, ELEV 542.6					
0.0	3.5	Sand, silty, w/12-15% fines, well graded, w/scattered cobbles, gravel	(SM)	0.5 - 1.5	30
				2.5 - 3.5	33
3.5	4.0	Silt, sandy, low plastic, trace fine sand & gravel	(ML)		
4.0	14.0	Sand, clayey, w/30-40% low plas. clay, brown, sand well graded	(SC)	4.5 - 5.5	40
				6.5 - 7.5	46
				10.5 - 11.5	47
14.0	27.0	Sand, w/12-20% low plastic silt, and silty sand, poorly stratified, trace of gravel	(SM)	16.5 - 17.5	93
				20.5 - 21.5	50
				25.5 - 26.5	55
27.0	30.0	Silt, w/traces of sand, low plastic, brown	(ML)	27.5 - 28.0	13*
30.0	35.0	Sand, silty, w/20-30% low plastic fines, sand well graded, w/trace gravel	(SM)	30.5 - 31.5	44
35.0	37.0	Sand and gravel, clean, water-bearing	(SP)	35.5 - 36.5	44
37.0	50.0	Sandy, silty, w/20-30% fines, sand well graded, gravel, angular glacial till	(SM)	40.5 - 41.5	60
				45.5 - 46.5	127
50.0	60.0	Cobbles, boulders w/matrix of silty sand	(GM)	50.5 - 51.5	55
60.0	62.0	Sand, silty, well graded 30-40% silt, fine to med. sand, very loose, wet	(SM)		
62.0	64.0	Sand, silty, well graded, w/gravel, w/20-30% silt, wet	(SM)	62.5 - 63.5	13
64.0	66.0	Sand, silty, w/20-30% fines, well graded, brown, glacial till	(SM)	64.5 - 65.5	43
DRILL HOLE 303, 70' RIGHT, ℄ DAM STA 14+70, ELEV 542.6					
0.0	6.0	Sand, w/8-12% low plas. silt, well graded w/trace of gravel, cobbles	(SW-SM)	0.5 - 1.5	14
				2.5 - 3.5	97
				4.5 - 5.5	30
6.0	16.0	Sand, clayey, w/25-35% mod. plastic fines, well-graded sand, trace gravel brown, dense	(SC)	6.5 - 7.5	50
				11.5 - 12.5	39
16.0	17.5	Clay, mod. plas. brown, very dense	(CL)	16.5 - 17.5	93
17.5	35.5	Sand, silty, w/12-20% fines, well graded, trace gravel, local poor stratification	(SM)	21.5 - 22.5	71
				26.5 - 27.5	73
				32.5 - 33.5	102
				34.5 - 35.5	67*

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLD 304, 150' RIGHT, ℄ DAM STA 14+70, ELEV 540.2					
0.0	2.5	Sand, silty, well graded brown	(SM)	0.5 - 1.5	12
2.5	13.0	Silt, low plas. gray-brown increasing clay @10-13 feet	(ML)	2.5 - 3.5	26
				4.5 - 5.5	20
				6.5 - 7.5	27
				10.5 - 11.5	58
13.0	26.0	Sand, w/12-15% silty fines, well graded sand, layers of clean sand, mod. to low perm.	(SM)	15.5 - 16.5	79
				21.5 - 22.5	68
26.0	27.5	Boulder			
27.5	31.0	Sand, clean, permeable	(SP)	28.0 - 29.0	90
31.0	35.0	Boulders			
35.0	37.0	Sand, silt, w/20-30% silt well graded, glacial till	(SM)	35.5 - 36.5	82
DRILL HOLE 501, 140' RIGHT, ℄ DAM STA 14+10, ELEV 541.6					
0.0	2.0	Silt, sandy, w/trace organic, wet, soft, brown-gray	(ML)	0.5 - 1.5	1
2.0	5.0	Sand, gravelly, silty, w/30-40% gravel & 10-14% low plas. silt, well graded, low perm., gray	(SM)	2.5 - 3.5	50
				4.5 - 5.5	45
5.0	10.0	Sand, silty, w/25-35% low plas. fines, well graded, trace gravel, brown	(SM)	6.5 - 7.5	20
10.0	26.0	Sand, silty, w/12-15% low plastic fines, trace gravel, well graded	(SM)	10.5 - 11.5	49
				15.5 - 16.5	74
				21.5 - 22.5	46
26.0	30.0	Sand, silty, w/20-30% low plastic fines, trace gravel, cobbles, well graded, low perm., glacial till	(SM)	26.5 - 27.5	43
DRILL HOLE 502, 170' RIGHT, ℄ DAM STA 15+35, ELEV 553.3					
0.0	7.0	Sand, damp, brown, silty, w/15-25% fines, trace gravel, well graded glacial till	(SM)	0.5 - 1.5	13
				2.5 - 3.5	49
				4.5 - 5.5	38
7.0	11.0	Clay, sandy, low plastic, w/thin lenses of fine to med. sand	(CL)	6.5 - 7.5	24
11.0	28.0	Clay, sandy, w/15-40% well graded sand and silt, sometimes stratified, brown and gray, low plastic	(CL)	11.5 - 12.5	37
				16.5 - 17.5	53
				22.5 - 22.5	50
				26.5 - 27.5	80
28.0	36.0	Sand, w/8-12% fines, silty, brown, some gravel well graded	(SW-SM)	31.5 - 32.5	61
36.0	40.6	Boulders, w/matrix of sand, gravel and silt			
40.6	58.0	Sand, silty, w/10-12% fines, some gravel well graded	(SW-SM)	41.0 - 42.0	42
				43.0 - 44.0	80*
				48.5 - 49.5	149
				55.0 - 55.5	80*
58.0	60.0	Sand, silty, w/20-40% fines, well graded, w/trace gravel, till	(SM)	58.5 - 59.5	41*

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 601, 70' RIGHT, ℄ DAM STA 11+90, ELEV 550.8					
0.0	0.8	Topsoil			
0.8	10.0	Sand, silty, w/12-15% silt, well graded, gravel, brown	(SM)	0.5 - 1.5	12
				2.5 - 3.5	25
				4.5 - 5.5	39
				6.5 - 7.5	98
				8.5 - 9.5	71
10.0	14.0	Sand, clayey, sand fine to med., w/15-30% plastic clay, low perm. gray streaked with brown	(SC)	10.5 - 11.5	25
				12.5 - 13.5	36
14.0	18.0	Sand, fine to med. poorly graded, w/10-15% fines, brown	(SM)	16.5 - 17.5	38
18.0	38.0	Sand, silty, w/12-15% fines, well-graded, brown, glacial till	(SM)	21.5 - 22.5	64
				26.5 - 27.5	131
				31.5 - 32.5	84
				36.5 - 37.5	98
DRILL HOLE 602, 95' RIGHT, ℄ DAM STA 13+00, ELEV 547.5					
0.0	.6	Topsoil			
.6	28.0	Sand, silty, well-graded, fine to coarse sand, w/trace of gravel, w/12-15% silty fines, glacial till	(SM)	0.5 - 1.5	11
				2.5 - 3.5	52
				4.5 - 5.5	88
				6.8 - 7.5	51
				10.5 - 11.5	40
				15.5 - 16.5	44
				20.5 - 21.5	33
				25.5 - 26.5	110
28.0	31.5	Boulder			
31.5	40.0	Sand, silty, well-graded, fine to coarse sand, w/trace of gravel, w/15-20% silty fines, glacial till	(SM)	35.5 - 36.5	40
DRILL HOLE 603, 80' RIGHT, ℄ DAM STA 13+60, ELEV 543.5					
0.0	15.0	Sand, silty, brown, well-graded, w/traces of cobbles and gravel, w/12-15% silt (variable to 8-12%) alluvium	(SM)	0.5 - 1.5	16
				10.5 - 11.5	87
15.0	26.5	Sand, well-graded med. to fine, clean water-bearing, permeable, alluvium	(SP)	15.5 - 16.5	55
				20.5 - 21.5	73
				25.5 - 26.5	76
26.5	35.0	Sand, silty, w/12-15% fines, well graded, low perm., brown, till	(SM)	30.5 - 31.3	140
35.0	37.0	Sand, silty, w/12-15% fines, well graded, gray, low perm., glacial till	(SM)	35.5 - 36.5	162

*300 lb hammer used on sampler

				Standard Penetration Depth	Blows/foot
DRILL HOLE 604, 75' RIGHT, ℄ DAM STA 14+30, ELEV 541.2					
0.0	4.5	Sand, fine to med., w/5-10% silty fines, poorly graded, gray-brown	(SP-SM)	0.5 - 1.5	3
				2.5 - 3.5	22
4.5	5.5	Sand, clayey, w/20-30% fines, well graded	(SC)	4.5 - 5.5	35
5.5	6.0	Clay, low plastic, brown	(CL)		
6.0	14.0	Sand, clayey, well graded, w/20-40% fines, trace gravel	(SC)	6.5 - 7.5	28
				8.5 - 9.5	38
				10.5 - 11.5	51
14.0	22.0	Sand, w/5-12% silty fines, well graded, trace of gravel, angular, permeable	(SW-SM)	16.5 - 17.5	94
				21.5 - 22.5	108
22.0	32.5	Sand, w/10-12% silty fines, well graded, mod. to low perm.	(SW-SM)	26.5 - 27.5	R
				31.5 - 32.5	40
32.5	47.0	Sand, silty, w/25-35% fines, trace gravel, cobbles, boulders; orange-brown, glacial till	(SM)	36.0 -	R
				41.5 - 42.5	58*
				46.5 - 47.5	R
DRILL HOLE 605, 60' RIGHT, ℄ DAM STA 14+90, ELEV 552.8					
0.0	2.0	Sand, damp, brown, silty, w/12-15% fines, gravelly	(SM)	0.5 - 1.5	6
2.0	11.0	Sand, silty, w/20-30% low plastic silt, well graded, brown, glacial till	(SM)	2.5 - 3.5	7
				4.5 - 5.5	22
				6.5 - 7.5	18
11.0	26.0	Clay, moist, gray, low plastic, trace of sand and gravel at top	(CL)	11.5 - 12.5	36
				16.5 - 17.5	50
				21.5 - 22.5	62
26.0	37.0	Sand, silty, moist brown, well graded w/8-12% fines, gravel, silt lenses, dense	(SW-SM)	26.5 - 27.5	50
				31.5 - 32.5	74
37.0	42.0	Silt, sandy, brown, sand-fine, poorly graded	(ML)	37.5 - 38.5	72
42.0	64.6	Sand, moist, brown, silty, w/15-25% fines, sand well graded, gravel, small boulders, glacial till	(SM)	42.5 - 43.5	163
				47.5 - 48.5	120
				53.5 - 54.5	55*
				58.5 - 59.5	53*
				63.5 - 64.5	99

*300 lb hammer used on sampler

DRILL HOLE 701, 75' LEFT, ℄ DAM STA 11+95, ELEV 548.4

				Standard Penetration Depth	Blows/foot
0.0	4.0	Silt, sandy, w/organic material, soft	(ML)	0.5 - 1.5	2
				2.5 - 3.5	0
4.0	5.0	Boulder			
5.0	15.0	Sand, silty, well-graded, fine to coarse sand, with trace of gravel	(SM)	5.5 - 6.5	145
				10.5 - 11.5	38
15.0	18.5	Sand, fine to med. well graded, w/5-10% fines	(SP-SM)	15.5 - 16.5	23
				17.5 - 18.5	41
18.5	28.0	Sand, silty, well-graded, w/15-20% fines	(SM)	20.5 - 21.5	34
				25.5 - 26.5	46
28.0	32.0	Sand, well-graded, w/trace of gravel, w/5-10% fines	(SP-SM)	30.5 - 31.5	50
32.0	37.0	Sand, well-graded, w/15-20% fines, till	(SM)	35.5 - 36.5	126

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Somerset, New Jersey 08873

RECEIVED
DEC 14 1978

DETAILED GEOLOGIC INVESTIGATION OF FURNACE BROOK SITE 2

General

State of New Jersey
Watershed - Furnace Brook
Site No. 2

Location - Warren County
Fund Class - (WP-08) 2013
Hazard Class - C

Investigated by: Ian R. Walker, Geologist
Drill Holes Date: 4/8/69-7/16/69
Test Pits Date: 7/14/69-7/31/69
Analysis and Report Date: 10/1/69

Equipment used: Drill holes: Sprague and Henwood Skid machine with 1 3/8 inch diameter split-barrel sampler
Test pits: Backhoe

Site Data

Drainage area size: 2.9 square miles 1,857 acres
Type of Structure: Earth Dam
Purpose of Structure: Flood water retarding, sediment storage and recreation

Storage Allocation

	Volume (Acre Feet)	Surface Area (Acres)	Depth at Dam (Feet)
Sediment	20		
Floodwater	487	68	42
Recreation	622	53	34

(must be w/ern) order

Dam Data

Maximum height: 51.5 feet
Length: 1,680 feet
Location of emergency spillway: Right abutment
Volume of fill: 177,000 cu. yds.

REFERENCE:	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 1 OF 11 DATE

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic area: Highlands

Topography: Right abutment
- Upper Slope 3%
- Lower Slope 50%

Left abutment 8%
Surface: steeply rolling
Relief: 700 feet
Width of flood plain: 350 feet

Geologic Formations and Surficial Deposits

Quaternary:

Recent: Alluvium
Silty sand, sand, gravel, and cobbles. Poorly stratified, low to moderate permeability. Underlies flood plain.

Pleistocene: Glacial till and interglacial fluvial and lacustrine deposits. An old till sheet everywhere overlies the bedrock. This deposit is in turn overlain by interglacial stream and lake deposits and finally by a second and younger till sheet.

The older till is a dense, slowly permeable silty sand with traces of gravel, cobbles, and boulders. Sand in fine to medium with from 15 to 40% low plastic silt and clay. Fluvial deposits overlying the old till sheet are variously sorted and stratified sand, gravel and silty sand deposits of moderate to high permeability. Lacustrine deposits of dense, impervious, low plastic clay overly the fluvial deposits.

The lacustrian deposits are in turn overlain by more fluvial deposits of fine to medium sand and silty sand of low to moderate permeability.

A young till sheet of dense and slowly permeable fine to medium silty and clayey sand blankets both abutments.

Precambrian: Granitoid Gneiss
Fractured and moderately permeable granitorid gneiss underlies the upper side of the left abutment at 20 feet and the right abutment and center of the site at depths in excess of 75 feet.

Structure

The Granitoid Gneiss is fractured and weathered for at least twenty feet below its surface which is buried beneath thick glacial and interglacial deposits. Generally the gneiss strikes northeast and dips to the southeast.

Evidence of Landslides, Seepage, Springs

There is no evidence of landslides or springs.

Seeps occur over a large area upstream of the dam on the left abutment; at the toe of the right abutment immediately upstream of the dam; and in a small area on the right abutment downstream of the dam.

The location and source of the seeps is shown on SCS-316B and SCS-316E. A discussion of the seeps is included under Left Abutment and Right Abutment in this report.

Sediment and Erosion

Average annual sediment delivery is expected to be 485.8 tons. The delivery rate to the reservoir will be 35 percent and a trap efficiency of 96 percent is expected. Total sediment storage allocation is 20 acre feet of which 17 acre feet will be submerged and 3 acre feet will be aerated. There is no change in these data from the work plan.

Downstream Channel Stability

The downstream channel is "paved" with a foot or more of gravel, cobbles, and sand.

SUBSURFACE GEOLOGY

EMBANKMENT FOUNDATION

Sixteen holes were drilled into the abutments and through the flood plain. The holes were sampled continuously by 1 3/8 inch split-barrel sampler for the top 8 to 15 feet and discontinuously thereafter every three or five feet. The deepest hole (D-7) was 75 feet deep and the shallowest hole (D-14) was 18 feet deep. Two backhoe test pits were dug on the dam center line. No undisturbed samples were collected.

Left Abutment

The left abutment is underlain by fractured gneiss, glacial till and a trace of interglacial silts and sands. All materials are generally

dense to very dense. One permeable zone of cobbles and boulders was found in D-4 (25 feet per day between 10 and 12 feet).

Permeabilities are about 5 fpd in the fractured and weathered gneiss which is overlain by cobbles and boulders (permeability of 5.4 fpd) and at least 20 feet of glacial till. Gneiss is generally at least fifty feet below the surface in the left abutment.

Glacial till in the left abutment is slowly permeable but the till is not homogeneous and contains scattered pockets and stringers of permeable sand, gravel, cobbles and boulders (as in DH 4, 10-12 feet).

Permeable interglacial sands and gravel occur near the surface immediately upstream of the dam center line in the left abutment (SCS-316B and SCS-316E). Seeps eminating from this deposit are believed to be supplied with ground water from the fractured gneiss (SCS-316E) and buried interglacial deposits.

Right Abutment

The right abutment is underlain by dense but variously permeable glacial till, fluvial sands, gravels, and silt and lacustrine clay. Bedrock was not found to depths of 72 feet beneath the right abutment.

Glacial till of low permeability (less than 0.2 fpd) occurs under and over the interglacial deposits. The till is a low plastic clayey or silty fine to medium angular sand containing scattered gravel, cobbles and boulders.

Permeable (to 18 fpd) sand and gravel deposits occur at depths of 40 to 50 feet beneath the abutment. Those deposits are discussed under Center Section of Center Line of Dam.

A dense, nearly impermeable low plastic clay overlies the permeable sand and gravel deposits.

Interglacial sand and silty sand covers some of the deeply eroded surface of the interglacial clay (SCS-316C). One channel fill deposit (SCS-316E, D-12, D-13, D-14) passes nearly through the right abutment. A 9-12 foot cover of dense and slowly permeable glacial till (T-603 to T-609, SCS-316A) blankets the sand in the normal pool area. The channel deposit is a fine to medium poorly stratified sand containing generally less than 12 percent low plastic silt.

Seepage in the right abutment 250 feet downstream from the toe of the dam is believed to originate in this buried channel deposit.

REFERENCE:	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 4 OF 11 DATE

Perennial seepage at the base of an abandoned sand pit just upstream of the center line of the dam (SCS-316B) originates in buried fluvial deposits in the right abutment (See Section A-A, SCS-316E). This deposit beneath the right abutment is of limited areal extent (SCS-316B).

Water levels in drill holes in the right abutment show ground water levels consistent with the geologic setting. A shallow or perched water table occurs within the root zone of the surficial glacial deposits. This water percolates downward to collect in the interglacial sand above the thick clay. Ground water in this sand is discharged through the abandoned sand pit, through seeps downstream of the toe of the dam, and very slowly through the underlying clay to the deeply buried fluvial sand and gravels. The deep sand and gravels are in turn drained by seepage upward to Furnace Brook beneath the center section of the dam center line.

Center Section of Center Line of Dam

Six drill holes were completed along the center section of the center line of the dam. The deepest was 75 feet deep.

This part of the dam is underlain by Recent alluvium, interglacial clays, silts, and sands, and glacial till.

The Recent alluvium is predominately coarse-grained and highly variable in texture and permeability. The alluvium is less than six feet thick on the right side of the flood plain and is 15 feet thick in a 100 foot wide channel on the left side of the flood plain.

Beneath the Recent alluvium is a nearly continuous (except on the left side) 9 to 18 foot thick layer of dense and slowly permeable low plastic clay, silt, and clayey sand.

Beneath the silt and clay is a buried interglacial channel containing deposits of sand and silty sand of variable permeability. These deposits extend laterally beneath the right abutment.

These deposits are very dense (SCS-316C). Permeabilities in clean poorly graded medium to coarse sands are in excess of 100 fpd but values of 15 to 25 fpd for the entire deposit are probably conservative. Horizontal permeabilities are far greater than vertical permeabilities.

The buried channel deposit continues downstream beneath the dam (SCS-316B and 316D) and the right abutment.

The buried channel deposit is underlain by dense and slowly permeable glacial till which in turn lies on gneiss at a depth in excess of 75 feet.

REFERENCE:	U.S.DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 5 OF 11 DATE

PRINCIPAL SPILLWAY

Four drill holes were completed along the center line of the principal spillway (SCS-316D).

In all cases the material below the surficial alluvium (3-6 feet) is dense. The buried channel which passes beneath D-303 is filled with dense fluvial deposits.

The deposits beneath the principal spillway are continuous beneath the center line of the dam and are discussed above under Center Section of Center Line of Dam.

EMERGENCY SPILLWAY

Two drill holes and sixteen test pits were completed in the emergency spillway. Disturbed samples were collected from both drill holes and from six test pits.

The 209,000 cubic yards of material (glacial till) in the emergency spillway is fine to medium sand with from 30 to 60 percent low plastic clay. The material (glacial till) is dense, moist and easily excavated with a backhoe. Scattered cobbles and a very few boulders were found in test pits. Cobbles and small boulders are common and, in some areas, numerous on the surface and within a foot of the ground surface.

The glacial till in the emergency spillway is virtually impermeable. A perched water table was found within the upper few feet of soil where root openings create a path for ground water movement. The quantity of water in this zone is not large and is directly dependent upon frequent rains.

No bedrock was found in two holes drilled 16 and 30 feet below the bottom of the center line of the emergency spillway.

BORROW AREAS

Borrow for the embankment will be taken entirely from the emergency spillway and is discussed above under EMERGENCY SPILLWAY.

General Description of Borrow	USCS	Location	Volume (c.y.)
Sand, fine to medium; 30 - 60% low pastic clay; scattered gravel cobbles and boulders; dense, moist, glacial till	SC	Emergency Spillway	209,000

RELIEF WELL EXPLORATION

Three drill holes were completed near the toe of the dam (SCS-316A and 316D, D-501, D-304, and D-502). The permeable buried channel deposits pass beneath the right abutment just upstream of the toe of the dam (SCS-316B).

Permeable sand was found at 20 feet and at 28 feet below the surface in D-304. These deposits are water-bearing and act as drains for the buried channel deposits which extends upstream beneath the pool area and beneath the right abutment. Samples for use in relief well design were not collected in this investigation.

RIPRAP

Hard, dense and durable rock is available from the surface of the emergency spillway in sizes ranging from cobbles to boulders to 18 inches in diameter. Six to eight thousand cubic yards of riprap are available on the surface and in fence rows in the emergency spillway.

INTERPRETATIONS AND CONCLUSIONS

The site is located in a valley carved into granitic gneiss and partially filled with glacial till, interglacial sand, silt and clay, and Recent alluvium.

The bedrock occurs at considerable depth beneath the unconsolidated deposits and, except in part of the left abutment where seeps originate in the rock, has little influence upon the structure.

Deep buried channel deposits are permeable and scattered discontinuous permeable zones occur within the generally very slowly permeable glacial till.

The following conditions are considered important to design and construction:

1. Buried channel deposits beneath the center section of the dam are continuous up and down stream.

2. The principal buried channel beneath the center section of the dam passes beneath the right abutment just upstream of the point of intersection of the stream and the toe of the dam.

3. The highly variable nature of the buried channel deposits dictates that samples for relief-well screen and/or gravel pack design be obtained from test wells at the site of the permanent relief wells. Samples will be difficult to obtain unless the artesian water level in the channel deposits is first lowered below the ground surface.

4. Silt and clay layers beneath the center section of the dam and the right abutment are dense and vary slowly permeable.

5. With the exception of thin surficial alluvial deposits beneath the flood plain the material beneath the structure is dense to very dense.

6. When a cutoff trench is constructed through the surficial alluvium beneath the center line a careful inspection should be made of the glacial till in the left abutment to detect and treat pockets or stringers of permeable material.

7. Unless treated during construction, the seeps in the base of the abandoned sand pit will interfere with the placement of fill at the base of the right abutment.

8. The upper buried alluvial channel which passes through the right abutment is effectively blanketed naturally in the normal pool area but without a blanket seepage will take place through the abandoned sand pit and into the buried channel deposit.

Jan Walker
Geologist

REFERENCE:	U.S.DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 8 OF 11 DATE

ENGINEERS REPORT

OF

PROPOSED TREATMENTS

1. During the site investigation numerous field drains were located at depths less than one foot. The entire area under the base of the dam will be cleared, grubbed and stripped to a depth of one foot. The stripping will cut off any field drains that might run under the embankment.

2. The right abutment has been subjected to borrowing operations which have resulted in steep irregular slopes. On the right abutment where the existing slope is greater than 3 to 1, it will be cut back to 3 to 1 under the embankment.

3. Right abutment: seepage control

   Two problems exist in the right abutment: (1) The sand pocket shown on sheet 316 B and, (2) the buried channel running under the right abutment, also shown on sheet 316 B.

   The sand pocket has been exposed in the pool area by past borrowing operations. Due to the high head and short seepage path together with the fact that the limits of the pocket as shown on sheet 316 B are not definite, it is believed that the use of a cut off is desirable. (See Sheet 316 CE and 316 AE)

   A check with the blanket aquifer method showed that the use of a blanket alone was not sufficient to handle the problem of seepage through the sand pocket. However, a blanket is being placed over the exposed borrow area since it provides a path for seepage to the buried channel. (See sheets 316 B and 316 E for problems and 316 AE and 316 CE for Solution.) It is also shown on sheet 316 E that the buried channel has a natural blanket (is pinched off) in the pool area and, therefore, no blanket is required on its upstream end.

4. Valley Floor: Recent Alluvium
   The Recent Alluvium will be cut off as shown on sheet 316 CE and 316 CE.

5. Valley Floor: Deep Deposits
   A check by the blanket aquifer method shows uplift pressures to be significant. The present thought is for the use of relief wells to handle this problem. Since we were unable to obtain samples of material into which the wells will be placed,

REFERENCE:	U.S.DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 9 OF 11 DATE

screen size and material gradations will have to be determined during construction. Location has also not been decided on. The wells will penetrate down into the interglacial fluvial deposits. Note on sheet 316 D on the section 150 feet downstream from the center line of dam that these deposits tend to neck down and move under the right abutment. Our belief is that this would be a good location to place the wells but we would appreciate your comments.

6. Embankment and Left Abutment:

The Embankment will consist of a homogeneous fill. All borrow will be obtained from the emergency spillway. Under these conditions do you believe a chimney drain is desirable. The Embankment drain will connect to the trench drain and will run into both abutments. Investigation in the left abutment showed pervious layers (see sheet 316 C and 316 E). These layers seem to be discontinuous up and down stream. The drain will be run up the left abutment to pick up any of this water which may move through. See sheets 316 AE, 316 FE, and 316 GE.

Please comment on or provide the following:

1. Proposed method of handling foundation.

2. Recommended location and design of relief wells, and their desirability.

3. Estimate total seepage loss through site.

4. If complete cutoff becomes necessary, due to water loss, what method of cutoff would you recommend. (Note this is a recreation site with a 53 acre lake.)

5. Structural Aspects of Site:
   The side slopes of 3:1 were proposed due to (1) The complexity of the sites foundation and, (2) the required emergency spillway excavation provides us with an excess of fill material.

6. Design of Drain:
   (a) Comment on depth and extent of trench drain
   (b) Design of Drain Fill Material
   The chimney drain will be entirely in the borrow material from the emergency spillway (Glacial Till). The trench drain will pass through the Recent Alluvium in the valley floor and predominately through glacial till in the abutments. (See sheet 316 FE.) Since no lenses of course material were located in the abutments during the site investigation the drain material will have to be designed with the glacial till as a base.

If during construction lenses of course material are encountered, the design of the drain fill will have to be adjusted accordingly.

7. Numerous seeps exist along the left abutment in the pool area. (See sheet 316 B.) It is our belief that since the existing static head is almost as high (see D-1 on sheet 316 C) as that which we are going to produce by ponding water to the normal pool elevation of 579.0, a blanket will not be necessary. We would appreciate your comments on this.

Carl Montana

CARL MONTANA
State Design Engineer

REFERENCE:	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. SHEET 11 OF 11 DATE

OPERATION AND MAINTENANCE AGREEMENT
FOR
STRUCTURAL MEASURES

THIS AGREEMENT made on October 30, 1968 is between the Soil Conservation Service, United States Department of Agriculture, hereinafter referred to as the Service, and the following organization(s), hereinafter referred to as the Sponsor:

Township of Oxford

The Sponsor and the Service agree to carry out the plan on the attached two pages for the operation and maintenance of structural measures in the

Furnace Brook

Watershed Project, State of New Jersey. The measures covered by this agreement are identified as:

1. Flood prevention -- recreation site on Furnace Brook approximately one mile upstream from Oxford.
2. Basic recreation facilities.
3. 0.3 mile of Stream Channel Improvement extending from the D.L.&W. Railroad north of Oxford to just downstream from the Washington Ave. bridge.

Name of Sponsor Township of Oxford

By Stephen Konrad Title Mayor

This action was authorized at an official meeting of the Sponsor named immediately above on 10/30/68 at Washington, N.J.

Attest Marie M. Beers Title Clerk

Soil Conservation Service, United States Department of Agriculture

By Richard W. Akeley Title STATE CONSERVATIONIST

OPERATION AND MAINTENANCE PLAN

I OPERATIONS

A. The sponsor will be responsible for and will operate or have operated without cost to the Service the structural measures in compliance with any applicable Federal, State and local laws, and in a manner that will assure that the structural measures will serve the purpose for which installed as set forth in the Work Plan.

B. The Service will, upon request of the Sponsor and to the extent that its resources permit, provide consultative assistance in the operation of the structural measures.

II MAINTENANCE

A. The Sponsor will:

1. Be responsible for and promptly perform or have performed without cost to the Service except as provided in Paragraph III, Establishment Period, all maintenance of the structural measures determined by either the Sponsor or the Service to be needed.

2. Obtain prior Service approval of all plans, designs and specifications for maintenance work involving major repair.

B. The Service will, upon request of the Sponsor and to the extent that its resources will permit, provide consultative assistance in the preparation of plans, designs and specifications for needed repair of the structural measures.

III ESTABLISHMENT PERIOD

A. During an Establishment Period, as herein defined, the Service will bear such part of the cost of any needed major repairs to the structural measures, including associated vegetative work, as is proportionate to the original construction costs borne by the Service in the construction of the structural measures except that the Service will not bear any of the cost for:

1. Repairs to channels or portions thereof which do not have permanent linings such as concrete, riprap, or grouted rock.

III ESTABLISHMENT PERIOD (continued)

2. Repairs determined by the Service to have been occasioned by improper operation or maintenance, or both.

3. Repairs applicable to municipal or industrial water supply or to any other purpose for which construction costs are not authorized to be paid for in whole or in part with funds appropriated to the Service.

4. Repairs that are mutually determined by the Sponsor and the Service as being items of normal maintenance rather than major repair and are not therefore in keeping with the spirit and intent of the Establishment Period provisions.

B. The Establishment Period for structural measures (exclusive of any associated vegetative work) is a period of three years ending at midnight on the third anniversary of the date on which the structural measure is accepted.

C. The Establishment Period for vegetative work associated with a structural measure is a period from date of acceptance of the initial vegetative work to midnight of the date on which the Service writes the Sponsor advising that an adequate vegetative cover has been obtained. However, this period shall not exceed two growing seasons or the end of the Establishment Period for the associated structural measure whichever is greater in time.

D. As used in the two preceding paragraphs, and elsewhere in this Plan, the following words have the meanings described below:

ACCEPTED, ACCEPTANCE: The date structural or vegetative measures are accepted from the contractor when a contract is involved, or the date structural or vegetative measures are completed to the satisfaction of the Service when force account operations are involved.

ADEQUATE VEGETATIVE COVER: A minimum of seventy percent (70%) cover of the desirable species, with no active rilling that cannot be controlled by the vegetation.

E. Major repair may involve such things as (1) repairing separated joints, cracks or breaks in the principal spillway, (2) correcting seepage, (3) replacing significant backfill around structures

III ESTABLISHMENT PERIOD (continued 2)

resulting from major erosion damage, (4) major revegetation due to failure to obtain an adequate vegetative cover, and (5) restoring areas with significant erosion caused by unusual flow (volume, recurrence or extended period of time) in emergency spillways.

F. No action with respect to needed repairs during the Establishment Period will be taken by the Sponsor or the Service which would lessen or adversely affect any legal liability of any contractor or his surety for payment of the cost of the repairs.

IV INSPECTIONS AND REPORTS

A. During the Establishment Period the Sponsor and the Service will jointly inspect the structural measures at least annually and after unusually severe floods or the occurrence of any other unusual condition that might adversely affect the structural measures. It is desirable the annual inspections be performed during the month shown below. Any supplemental inspections then determined necessary will be scheduled and agreed to at that time.

MAY
(Month)

B. After the Establishment Period the structural measures will be inspected annually by the Sponsor, preferably during the month shown below, and after unusually severe floods or the occurrence of any other unusual condition that might adversely affect the structural measures.

MAY
(Month)

C. After the Establishment Period the Service may inspect the structural measures at any reasonable time.

D. A written report will be made of each inspection. The report of joint inspections will be prepared by the Sponsor with the assistance of the Service. A copy of each report will be provided by the party preparing the report to the other party within ten days of the date on which the inspection was made.

V RECORDS

The Sponsor will maintain in a centralized location a record of all inspections performed both individually and jointly by the Sponsor and the Service, and of all significant actions taken by the Sponsor with respect to operation and maintenance. The Service may inspect these records at any reasonable time.

VI GENERAL

A. The Sponsor will:

1. Prohibit the installation of any structures or facilities that will interfere with the operation or maintenance of the structural measures.

2. Obtain prior Service approval of the plans and specifications for any alteration or improvement to the structural measures.

3. Obtain prior Service approval of any agreement to be entered into with other parties for the operation or maintenance of all or any part of the structural measures, and provide the Service with a copy of the agreement after it has been signed by the Sponsor and the other party.

B. Service personnel will be provided the right of free access to the structural measures at any reasonable time for the purpose of carrying out the terms of this plan.

C. The responsibilities of the Sponsor under this Plan are effective simultaneously with the acceptance of the works of improvement in whole or in part.

VII SPECIAL PROVISIONS

Exhibit 2910

PROPERTY MANAGEMENT STANDARDS
(Attachment to Operation and Maintenance Agreement)

The standards prescribed herein govern the utilization and disposition of property furnished by SCS or acquired in whole or in part with SCS-furnished funds by the sponsors. Sponsors are responsible for observing the standards set forth herein. Sponsors are authorized to use their own property management standards and procedures as long as the provisions set forth herein are included.

1. Definitions

(a) Real property. Real property means land, land improvements, structures and appurtenances thereto, excluding movable machinery and equipment.

(b) Personal property. Personal property means property of any kind except real property. It may be tangible -- having physical existence, or intangible -- having no physical existence, such as patents, inventions, and copyrights.

(c) Nonexpendable personal property. Nonexpendable personal property means tangible personal property having a useful life of more than one year and an acquisition cost of $300 or more per unit. A sponsor may use its own definition of nonexpendable personal property provided that such definition would at least include all tangible personal property as defined above.

(d) Expendable personal property. Expendable personal property refers to all tangible personal property other than nonexpendable property.

(e) Excess property. Excess property means property under the control of any federal agency which, as determined by the head thereof, is no longer required for its needs.

2. Use of Real Property

Sponsors shall use any real property acquired partly or wholly with SCS financial assistance, as long as needed for the purpose for which it was acquired and in accordance with the O&M agreement. When the real property is no longer needed for the purpose of the SCS financial assistance, the sponsor shall obtain SCS approval of its plans for future use or disposition.

3. Use of Nonexpendable Personal Property

(a) Nonexpendable personal property acquired with federal funds. When nonexpendable personal property is acquired by a sponsor wholly or in part with federal funds, title will not be taken by the federal government, but shall be vested in the sponsor subject to the following restrictions on use and disposition of the property:

(1) The sponsor shall retain the property acquired with federal funds in the federally financially assisted program as long as there is a need for the property to accomplish the purpose of the program whether or not the program continues to be supported by federal funds. When there is no longer a need for the property to accomplish the purpose of the federally financially assisted program, the sponsor shall use the property in connection with other federal grants it has received in the following order of priority:

(i) Other grants of the SCS needing the property.

(ii) Grants of other federal agencies needing the property.

(2) When the sponsor no longer has need for the property in any of its federal grant programs, the property may be used for its own official activities in accordance with the following standards:

(i) Nonexpendable property with an acquisition cost of less than $500 and used four years or more. The sponsor may use the property for its own official activities without reimbursement to SCS or sell the property and retain the proceeds.

(ii) All other nonexpendable property. The sponsor may retain the property for its own use provided that a fair compensation is made to the SCS for the SCS share of the cost of the property. The amount of compensation shall be computed by applying the percentage of SCS participation in the SCS financially assisted undertaking to the current fair market value of the property.

(3) If the sponsor has no need for the property, disposition of the property shall be made as follows:

(i) Nonexpendable property with an acquisition cost of $1,000 or less. Except for that property which meets the criteria of (2) (i) above, the sponsor shall sell the property and reimburse the SCS an amount which is computed in accordance with the last paragraph in (ii) below.

(ii) Nonexpendable property with an acquisition cost of over $1,000. The sponsor shall request disposition instructions from SCS. The SCS shall determine whether the property can be used to meet a SCS requirement. If no requirement exists within SCS, the availability of the property shall be reported to the General Services Administration (GSA) by the SCS to determine whether a requirement for the property exists in other federal agencies. The SCS shall issue instructions to the sponsor within 120 days and the following procedures shall govern:

If the sponsor is instructed to ship the property elsewhere, the sponsor shall be reimbursed by the benefiting federal agency with an amount which is computed by applying the percentage of the sponsor participation in the SCS financially assisted undertaking to the current fair market value of the property, plus any shipping or interim storage costs incurred.

If the sponsor is instructed to otherwise dispose of the property, he shall be reimbursed by the SCS for such costs incurred in its disposition.

If disposition instructions are not issued within 120 days after reporting, the sponsor shall sell the property and reimburse the SCS an amount which is computed by applying the percentage of SCS participation in the undertaking to the sales proceeds. Further, the sponsor shall be permitted to retain $100 or 10 percent of the proceeds, whichever is greater for the sponsor's selling and handling expenses.

4. Other Requirements for Nonexpendable Personal Property

The sponsor's property management standards for nonexpendable personal property shall also include the following procedural requirements:

(a) Property records shall be maintained accurately and provide for: a description of the property; manufacturer's serial number or other identification number; acquisition date and cost; source of the property; percentage of federal funds used in the purchase of property; location, use, and condition of the property; and ultimate disposition data including sales price or the method used to determine current fair market value if the sponsor reimburses SCS for its share.

(b) A physical inventory of property shall be taken and the results reconciled with the property records at least once every two years to verify the existence, current utilization, and continued need for the property.

(c) A control system shall be in effect to insure adequate safeguards to prevent loss, damage, or theft to the property. Any loss, damage, or theft of nonexpendable property shall be investigated and fully documented.

(d) Adequate maintenance procedures shall be implemented to keep the property in good condition.

(e) Proper sales procedures shall be established for unneeded property which would provide for competition to the extent practicable and result in the highest possible return.

5. Expendable Personal Property

When the total inventory value of any unused expendable personal property exceeds $500 at the expiration of need for any federal grant purposes, the sponsor may retain the property or sell the property as long as it compensates SCS for its share in the cost. The amount of compensation shall be computed in accordance with 3(a)(2)(ii) above.

6. Intangible Personal Property

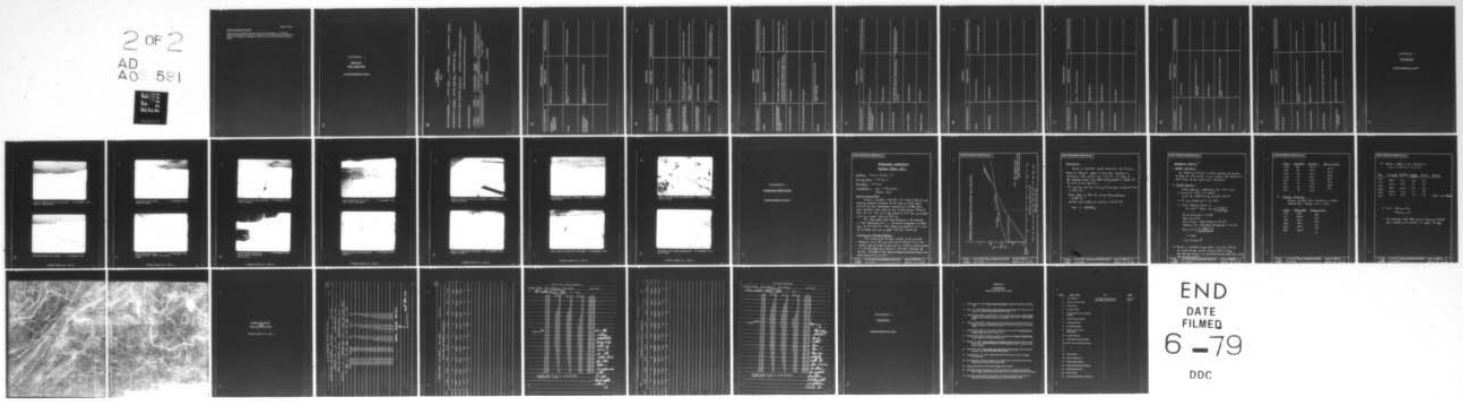
(a) If any program produces patents, patent rights, processes, or inventions, in the course of work aided by a SCS financial assistance, such fact shall be promptly and fully reported to SCS. The SCS shall determine whether protection on such invention or discovery shall be sought and how the rights in the invention or discovery--including rights under any patent issued thereon-shall be disposed of and administered in order to protect the public interest consistent with "Government Patent Policy" (President's Memorandum for Heads of Executive Departments and Agencies, August 23, 1971, and Statement of Government Patent Policy as printed in 36 F.R. 16889).

(b) Where the SCS financial assistance results in a book or other copyrightable material, the sponsor is free to copyright the work, but SCS reserves a royalty-free, nonexclusive and irrevocable license to reproduce, publish, or otherwise use, and to authorize others to use the work for government purposes.

AD-A068 591 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. FURNACE BROOK W. S. DAM NUMBER 2 (--ETC(U)
APR 79 D J LEARY DACW61-78-C-0124

UNCLASSIFIED NL

2 OF 2
AD
A068 591



END
DATE
FILMED
6-79
DDC

PROPERTY MANAGEMENT STANDARDS

Exhibit 2910 is attached and made a part of this agreement. It contains prescribed standards governing the utilization and disposition of property furnished by the Service or acquired in whole or in part with Service-furnished funds.

APPENDIX 2

CHECK LIST

VISUAL INSPECTION

FURNACE BROOK W.S. DAM 2

CHECK LIST
VISUAL INSPECTION

Phase I

NAME DAM Furnace Brook COUNTY Warren STATE New Jersey COORDINATORS N.J.D.E.P.

DATE(s) INSPECTION See below WEATHER Partly cloudy TEMPERATURE 40° F

POOL ELEVATION AT TIME OF INSPECTION 573.16* M.S.L. TAILWATER AT TIME OF INSPECTION 539.67* M.S.L.

* Elevations from drawings provided by Soil Conservation Service

INSPECTION PERSONNEL:

D. Leary 12/14/78	D. Smart (Biologist) 12/14/78	B. Irwin (Soil Conservation Service) 12/14/7
J. Richards 12/14/78	R. Coppersmith (C. Douglas Cherry & Assoc.) 12/14/78	C. Campbell (1/10/79)
L. Holt (Soil Conservation Service) 12/14/78	P. Yu (1/10/79)	J. Rizzo (1/10/79)

James Richards RECORDER

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Appears Satisfactory	
SLOPES	Slopes eroded in more than two areas to depths of 1 to 2 ft.	Eroded areas should be repaired.
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 10 homes (from USGS Topo Map). Population est. 30.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None Observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None Observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion 1.5' deep along left to downstream of dam to outlet channel. Several 1" - 2" deep erosion trenches on downstream face.	Eroded area should be repaired. Small erosion trenches should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appears Satisfactory.	
RIPRAP FAILURES	Riprap at north end of dam is incomplete. Riprap at auxiliary spillway is missing.	Riprap sizes to 3.5 ft diameter. Large pieces of riprap randomly placed.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OTHER	Several small animal burrow holes 2 inches to 4 inches in diameter.	Holes should be suitably filled.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Left abutment - ponding water in rut of toe of dam. At inlet of CMP leading to spillway discharge channel on downstream face, erosion of 6 inches in depth, 5 ft sq area.	Suitable drainage should be provided. Eroded area should be repaired.
ANY NOTICEABLE SEEPAGE	None Observed	
STAFF GAGE AND RECORDER	None Observed	
DRAINS	Two 5½ inch drains at outlet structure operating. Appear satisfactory.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None Observed.	
INTAKE STRUCTURE	Appears adequate.	
OUTLET STRUCTURE	Left embankment/impact basin junction, erosion 1.5 ft deep, 1 ft - 2.5 ft wide, 15 ft long. Large boulder abuting concrete.	Eroded area should be repaired. Boulder should be removed.
OUTLET CHANNEL	Appears Satisfactory	
EMERGENCY GATE	None Observed	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARK OR RECOMMENDATIONS
SLOPES	Several small eroded areas.	Eroded areas should be repaired.
SEDIMENTATION	Not observable	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None. Auxiliary spillway is grassed.	
APPROACH CHANNEL	Appears Satisfactory	
DISCHARGE CHANNEL	Appears Satisfactory	
BRIDGE AND PIERS	None Observed	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed	
WELLS	2 large relief wells located downstream near impact basin.	
WEIRS	None Observed	
PIEZOMETERS	Two open well piezometers observed and appear unused.	
OTHER		

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
CONCRETE SILL	Appears satisfactory	
APPROACH CHANNEL	Piece of dead wood lodged in sluice gate on left side of spillway.	Wood should be removed.
DISCHARGE CHANNEL	Appears Satisfactory	
BRIDGE AND PIERS	Wooden plank from riprap to spillway used for access.	More substantial walkway should be made.
GATES AND OPERATION EQUIPMENT	Operators appear satisfactory.	Wood log in gate should be removed.

APPENDIX 3

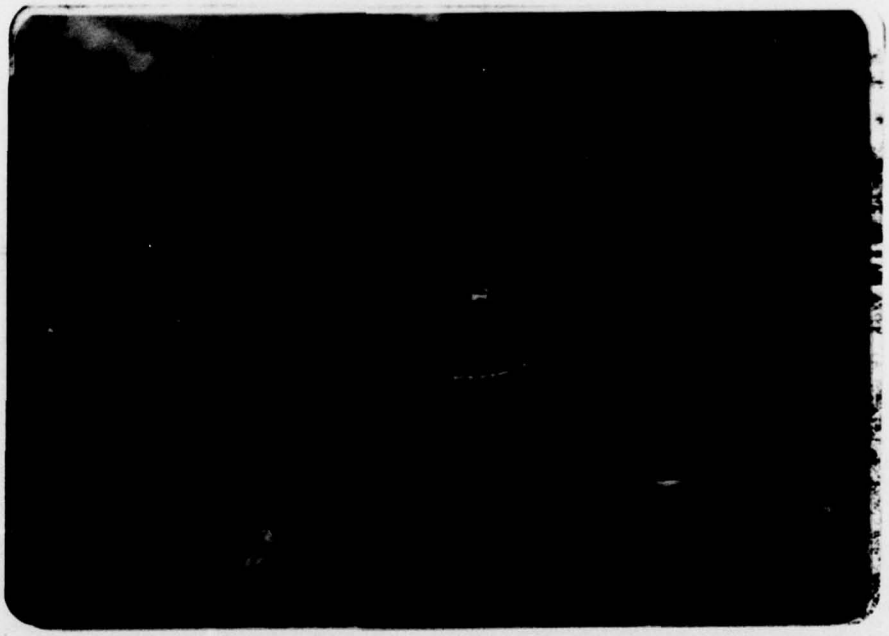
PHOTOGRAPHS

FURNACE BROOK W.S. DAM 2

View of dam and outlet structure. 14 December 1978
Looking downstream.

Upstream slope and riprap. 14 December 1978

View along dam crest. 14 December 1978
Looking south.

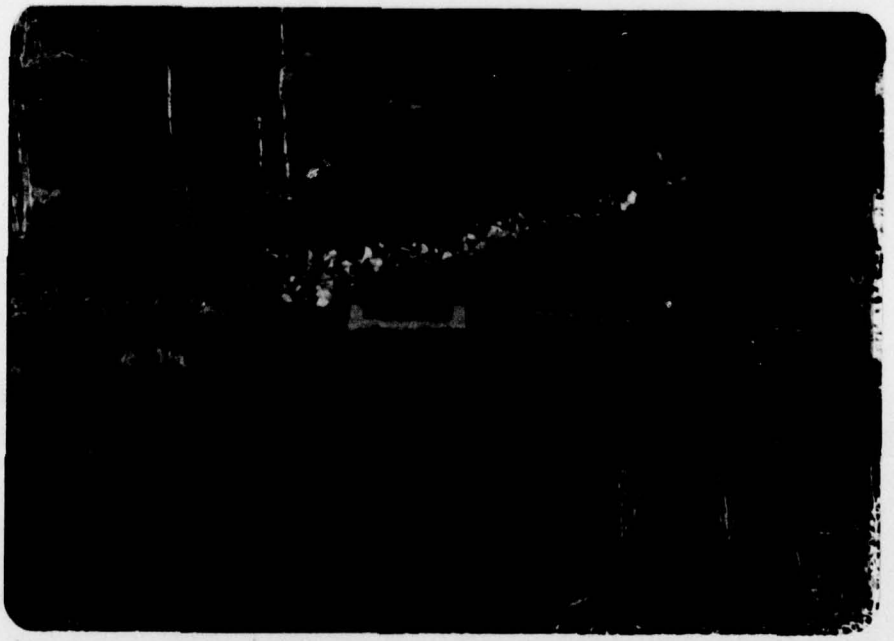


View along dam crest. 14 December 1978
Looking north. Note ruts along
crest.

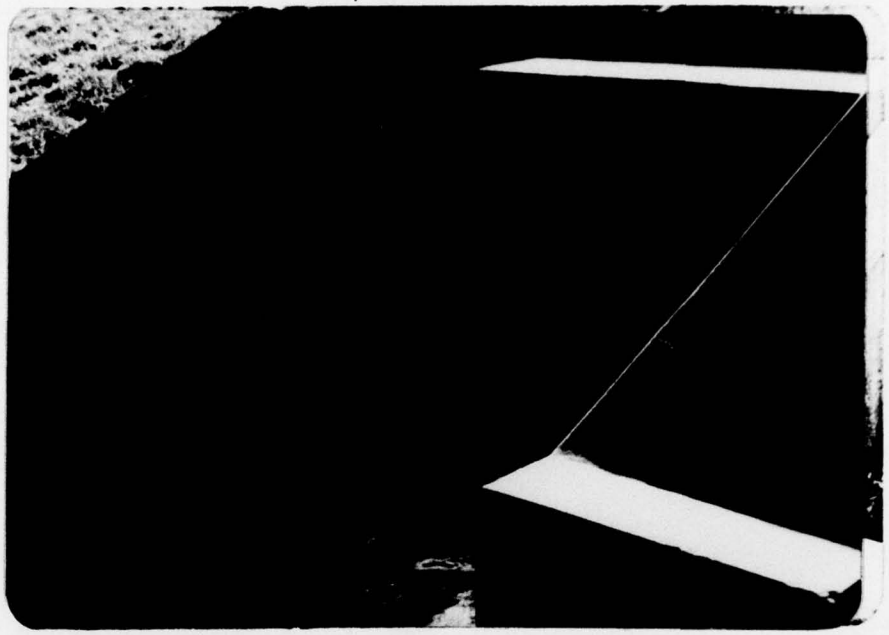
Junction of dam and spillway inlet channel. 14 December 1978

Deteriorated riprap at north end of dam below Buckley Ave. 14 December 1978

Gate operators at top of drop inlet spillway. 14 December 1978

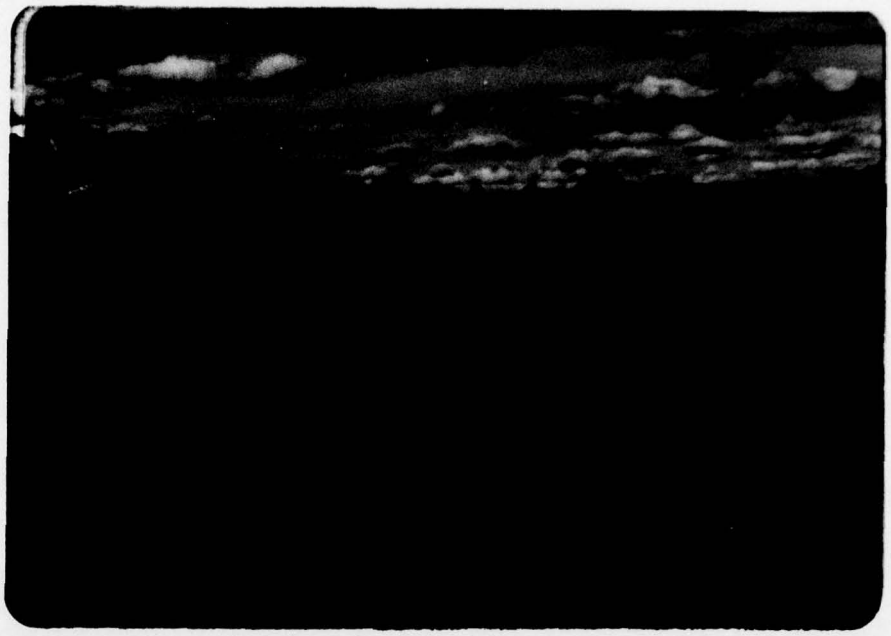


Impact basin and discharge channel. 14 December 1978



Impact basin at end of principal spillway pipes — 14 December 1978

Crest of auxiliary spillway. Looking south. — 14 December 1978



Auxiliary spillway. Looking downstream. 14 December 1978

Left side of auxiliary spillway. 14 December 1978

Animal burrow hole in downstream slope of dam. 14 December 1978

Drainage ruts along downstream toe of dam. 14 December 1978

APPENDIX 4

HYDROLOGIC COMPUTATIONS

FURNACE BROOK W.S. DAM 2

LANGAN ENGINEERING ASSOCIATES, INC.

HYDROLOGIC COMPUTATIONS

FURNACE BROOK DAM

Location : Warren County, N.J.

Drainage Area : 2.87 sq. mi.

Lake Area : 53 Acres

Classification : Size – Intermediate
Hazard – High

Spillway Design Flood :

Based on available information, the crest of the auxiliary spillway has been designed on the basis of 100 yr storm determined from hydrographs produced by rainfalls taken from hydrologic maps based on U.S. Weather Bureau Technical Paper No. 40. This storm equivalents to 8.4 inches of rainfall and has a peak inflow of 893 cfs.

The top of dam has been designed on the basis of a PMF determined from the freeboard hydrograph rainfall from ES 1020 sh.5 of 5. This flood equivalents to 25.3 inches of rainfall and has a peak inflow of 15888 cfs.

Spillway and Storage Capacity

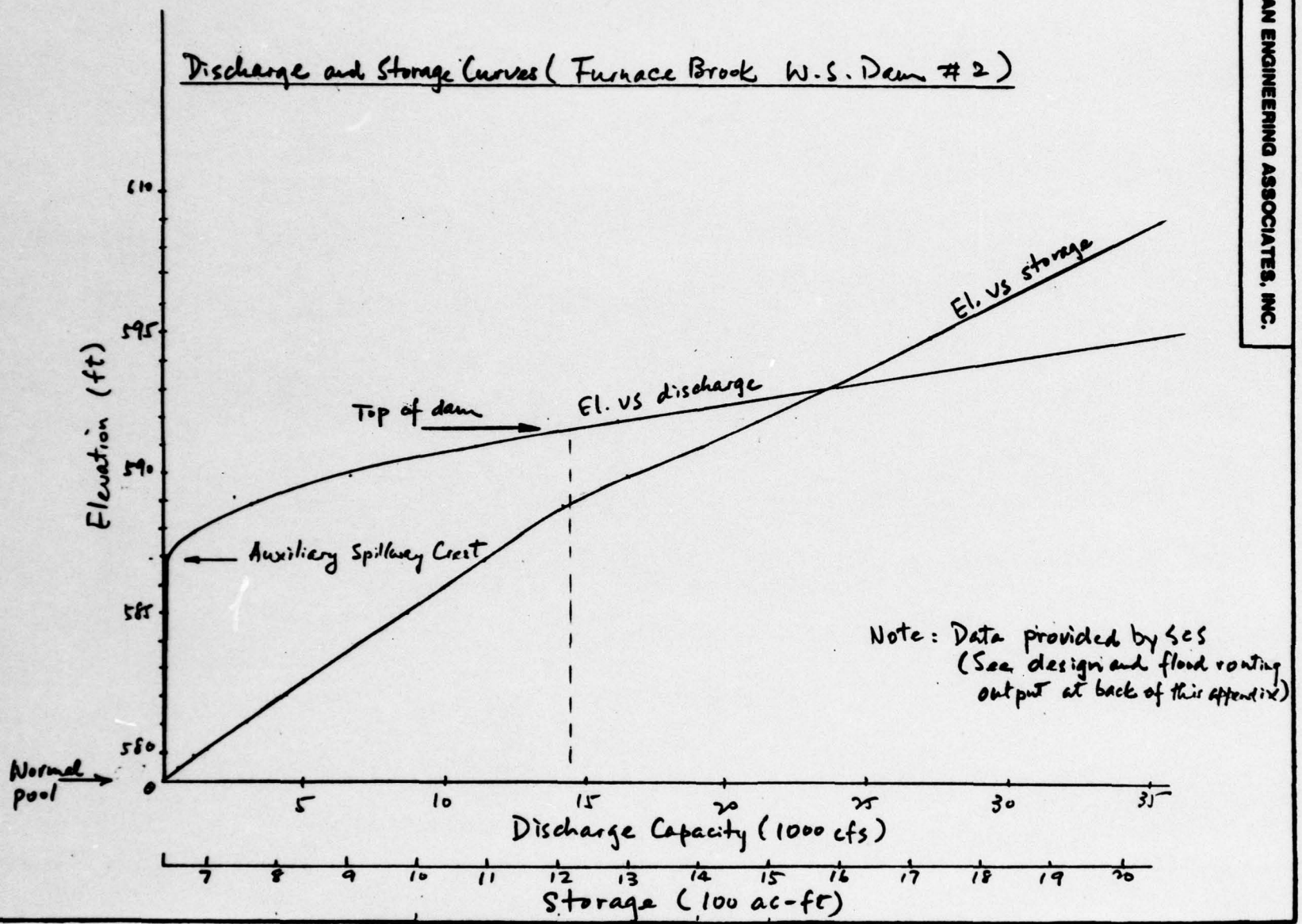
The spillway for this dam consists of the principal spillway, a drop inlet riser which leads to 30"ϕ R.C.P., in the upstream side of center of dam and an auxilliary spillway which is a 500 ft grassed open channel in the right abutment of the dam. The data for the spillway discharge and reservoir storage curves were provided to us by SCS.

LANGAN ENGINEERING ASSOCIATES, INC.

BY [illegible] DATE 2-13-79 Furnace Brook W.S. Dam #2 JOB NO. T-783-13

CKD&CED DATE 4-10-79 SHEET NO. 2 OF 6

Discharge and Storage Curves (Furnace Brook W.S. Dam #2)



Note: Data provided by SCS
(See design and flood routing output at back of this appendix)

LANGAN ENGINEERING ASSOCIATES, INC.

EVALUATION

Based on available design informations, the Furnace Brook W.S. Dam # 2 appears to have been designed in accordance with present day criterion. A copy of the hydrologic design and flood routing output is included at the back of this appendix.

The maximum spillway capacity at top of dam elevation (El. 591.6) ≐ 14500 cfs.

Peak inflow of PMF for Furnace Brook Watershed = 15588 cfs

Routed peak outflow at spillway = 14363 cfs

∴ dam is satisfactory

LANGAN ENGINEERING ASSOCIATES, INC.

DRAWDOWN ANALYSIS*

1. Outlet Structure

One 80 ft long 18"Φ R.C.P. from upstream toe of dam to base of riser which in turn leads to the 30"Φ R.C.P. that drains to the impact basin downstream.

2. Outlet Capacity

Outlet capacity controlled by the 18"Φ section.

a. Invert at inlet = El. 543.5
Invert at outlet (in base of riser) = 543.25

b. El. of recreation pool ≐ El. 579

c. Pipe capacity based on

$$Q = C_p H^{1/2} \text{ where } C_p = A_p \sqrt{\frac{2g}{1+K_m+K_p L}}$$

A_p for 18"Φ pipe = 1.77 ft²
take $n = 0.014$
$K_p = 0.0211$ (NEH Section 5, ES-42)
use $K_m = 0.8$ (Handbook of Hydraulics P.6-18)

$$C_p = 1.77 \sqrt{\frac{64.4}{1+0.8+0.0211 \times 80}}$$

$$= 7.606$$

$$\therefore Q = 7.606\, H^{1/2}$$

* Based on available design data, more than 50% of the flood storage can be removed within 10 days. Therefore this analysis only considers the drawdown below the crest of the principal spillway.

BY. [illegible] DATE 2-13-79 Furnace Brook W.S. Dam #2 JOB NO. J-783 B
CKD [illegible] DATE 4-10-79 SHEET NO. 4 OF 6

Elev.	Head (ft)	Q (cfs)	Qout avg. (cfs)
579	36	45.6	
			44.7
576	33	43.7	
			42.4
572	29	41.0	
			39.5
568	25	38.0	
			36.5
564	21	34.9	
			33.2
560	17	31.4	
			29.4
556	13	27.4	
			25.1
552	9	22.8	

3. Storage Capacity

Storage capacity below recreation pool elevation obtained from design file in SCS.

Elev.	Storage (AF)	Δ Storage (AF)
579	640	
		153
576	486.9	
		167
572	320	
		132
568	188.1	
		100
564	88.2	
		63
560	25.3	
		25

LANGAN ENGINEERING ASSOCIATES, INC.

4. Assume inflow to be 2 cfs/sq.mi
$Q_{in} = 2.67 \times 2 = 5.7$ cfs.

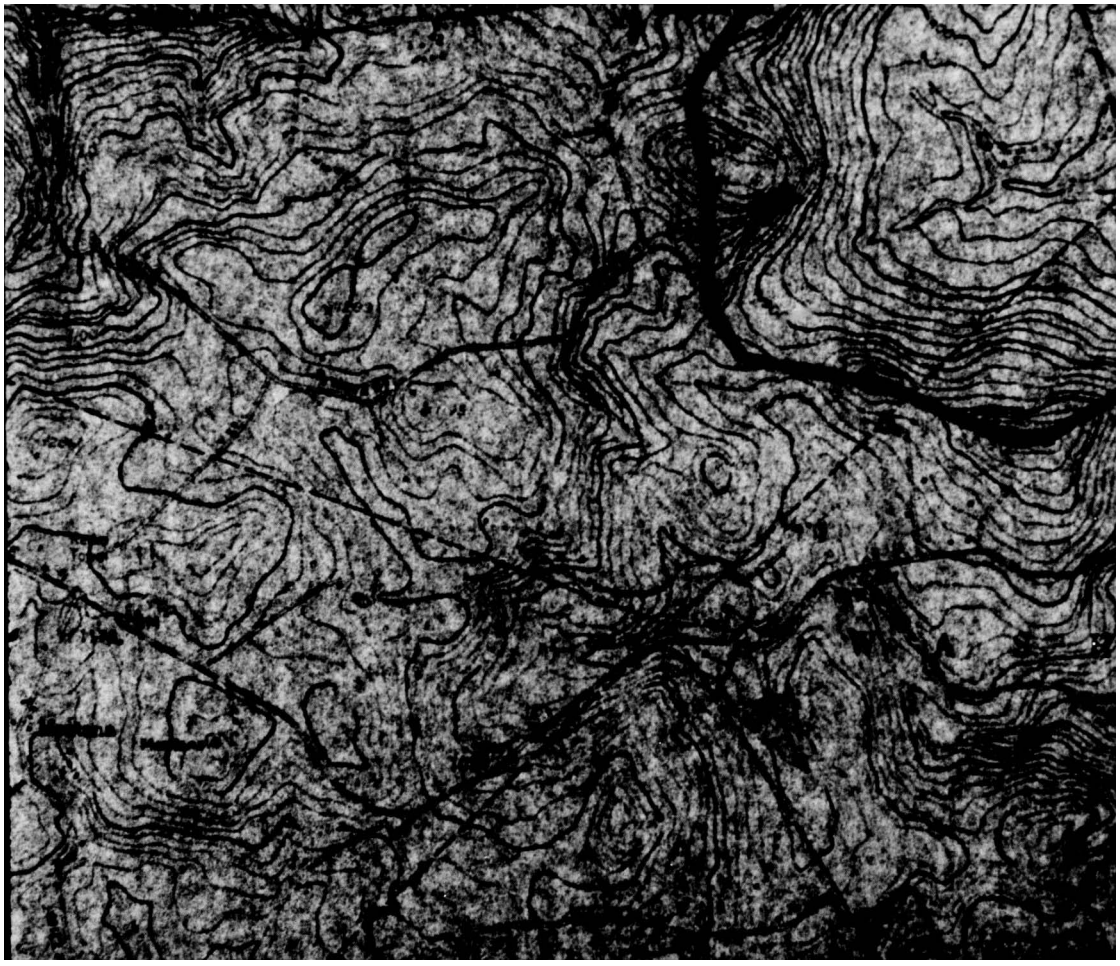
Elev.	$Q_{out\,avg}$ (cfs)	Q_{net}^{*} (cfs)	ΔStorage (Ac-ft)	Δt (hr)	$\Sigma \Delta t$ (hr)
579	44.7	39	153	47	
576	42.4	36.7	167	55	
572	39.5	33.8	132	47	
568	36.5	30.8	100	39	
564	33.2	27.5	63	28	216 or 9 days
560					

* $Q_{net} = Q_{out\,avg} - Q_{in}$
$= Q_{out\,avg} - 5.7$

∴ We estimate that lake can be lowered 19 feet from recreation pool elevation in approx. 9 days

BY TJy DATE 2-13-79 Furnace Brook W.S. Dam #2 JOB NO. J-783 B
CKD GED DATE 4.10.79 SHEET NO. 6 OF 6


ROAD
M
319



HYDROLOGIC DESIGN
AND
FLOOD ROUTING OUTPUT

FURNACE BROOK W.S. DAM 2

E. S. DESIGN AND FREEBOARD ROUTINGS. (66)

FURNACE BROOK SITE NUMBER 2 NEW JERSEY CJM 9-68

CURVE NO. 69. TC 1.20 STORM DURATION 6.00

EMER. SPW. RAINFALL 10.40 FREEBOARD RAINFALL 25.30

CASE NO. 4. DRAINAGE AREA 2.87 EMER. SPW. CREST 586.9

B01 400. L1 230. B02 500. L2 230. B03 600. L3 230.

ELEVATION	STORAGE	CFS	CFS	CFS
579.00	640.	0.	0.	0.
579.44	661.	3.	3.	3.
579.88	682.	9.	9.	9.
580.31	707.	17.	17.	17.
581.19	759.	32.	32.	32.
581.80	794.	60.	60.	60.
582.20	817.	88.	88.	88.
582.59	840.	122.	122.	122.
582.71	847.	132.	132.	132.
585.00	988.	135.	135.	135.
586.90	1096.	137.	137.	137.
587.90	1153.	939.	1139.	1339.
588.90	1210.	2540.	3140.	3740.
589.00	1216.	2821.	3491.	4161.
589.90	1302.	5342.	6642.	7942.
590.90	1398.	8543.	10643.	12743.
591.00	1408.	8984.	11194.	13404.
591.90	1482.	12945.	16145.	19345.
594.90	1729.	28149.	35149.	42149.
598.90	2058.	56154.	70154.	84154.
599.00	2067.	57055.	71281.	85506.
601.00	2242.	75057.	93783.	112508.

400'B.W. 500'B.W. 600' B.W.

used this one

FURNACE BROOK SITE NUMBER 2 NEW JERSEY CJM 9-68

EMER. SPW. INTERVENING HYDROGRAPH.

TIME	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2
0.00	0.	0.	0.	0.	0.	2.	22.	96.	291.	6
2.50	2008.	3591.	4676.	4815.	4328.	3721.	3230.	2864.	2552.	22
5.00	1974.	1782.	1658.	1577.	1496.	1342.	1082.	775.	509.	3
7.50	210.	131.	81.	50.	30.	18.	10.	4.	1.	
10.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	

EMER. SPW. DESIGN ROUTING.

FURNACE BROOK SITE NUMBER 2 NEW JERSEY CJM 9-68

Bot. Width → BO = 500. L = 230.

TIME	INFLOW	AVE IN	OUTFLOW	ELEV.	
0.25	0.	0.	0.	578.99	
0.50	0.	0.	0.	578.99	
0.75	0.	0.	0.	578.99	
1.00	0.	0.	0.	578.99	
1.25	2.	1.	0.	579.00	
1.50	22.	12.	0.	579.00	
1.75	96.	59.	0.	579.03	
2.00	291.	193.	0.	579.11	
2.25	808.	549.	2.	579.35	
2.50	2008.	1408.	10.	579.94	
2.75	3591.	2800.	27.	580.92	
3.00	4676.	4133.	103.	582.37	
3.25	4815.	4745.	133.	583.94	
3.50	4328.	4571.	135.	585.46	
3.75	3721.	4025.	137.	586.87	
4.00	3230.	3475.	1146.	587.90	
4.25	2864.	3047.	2158.	588.40	
4.50	2552.	2708.	2451.	588.55	← this
PEAK → 4.75	2242.	2397.	2422.	588.54	
5.00	1974.	2108.	2255.	588.45	writing
5.25	1782.	1878.	2054.	588.35	
5.50	1658.	1720.	1876.	588.26	established
5.75	1577.	1618.	1739.	588.19	
6.00	1496.	1537.	1631.	588.14	"Design High
6.25	1342.	1419.	1518.	588.08	
6.50	1082.	1212.	1356.	588.00	Water" of
6.75	775.	929.	1133.	587.89	
7.00	509.	642.	982.	587.74	588.6 —
7.25	329.	419.	809.	587.57	
7.50	210.	269.	643.	587.40	ie. the
7.75	131.	170.	498.	587.26	
8.00	81.	106.	378.	587.13	"take-line"
8.25	50.	66.	282.	587.04	
8.50	30.	40.	208.	586.97	for this
8.75	18.	24.	151.	586.91	
9.00	10.	14.	137.	586.86	take —
9.25	4.	7.	137.	586.81	
9.50	1.	3.	137.	586.77	in conformance
9.75	0.	0.	137.	586.72	
10.00	0.	0.	137.	586.67	with

VOLUME CHECK AT HP IS 0.08 PERCENT.
COMPUTED HP 1.65

PL-566 land rights criteria.

2

FURNACE BROOK SITE NUMBER 2 NEW JERSEY CJM 9-68

FREEBOARD INTERVENING HYDROGRAPH.

TIME	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2
0.00	0.	0.	0.	10.	67.	262.	702.	1399.	2462.	44
2.50	8454.	13158.	15888.	15600.	13544.	11340.	9607.	8331.	7288.	63
5.00	5492.	4905.	4523.	4265.	4020.	3592.	2890.	2067.	1357.	8
7.50	559.	350.	217.	134.	82.	48.	26.	12.	4.	
0.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	

FREEBOARD ROUTING.

FURNACE BROOK SITE NUMBER 2 NEW JERSEY CJM 9-68

Bottom Width → BO = 500. L = 230.

TIME	INFLOW	AVE IN	OUTFLOW	ELEV.
0.25	0.	0.	0.	578.99
0.50	0.	0.	0.	579.00
0.75	10.	5.	0.	579.00
1.00	67.	39.	0.	579.01
1.25	262.	165.	0.	579.09
1.50	702.	482.	2.	579.29
1.75	1399.	1050.	7.	579.75
2.00	2462.	1930.	19.	580.45
2.25	4484.	3473.	54.	581.66
2.50	8454.	6469.	133.	583.86
2.75	13158.	10806.	768.	587.52
3.00	15888.	14523.	8195.	590.28
3.25	15600.	15744.	13432.	591.40
3.50	13544.	14572.	14363.	591.57
3.75	11340.	12442.	12795.	591.29
4.00	9607.	10474.	10926.	590.95
4.25	8331.	8969.	9694.	590.66
4.50	7288.	7810.	8560.	590.37
4.75	6311.	6800.	7500.	590.11
5.00	5492.	5901.	6547.	589.87
5.25	4905.	5199.	5809.	589.66
5.50	4523.	4714.	5210.	589.49
5.75	4265.	4394.	4763.	589.36
6.00	4020.	4143.	4424.	589.26
6.25	3592.	3806.	4086.	589.16
6.50	2890.	3241.	3523.	589.03
6.75	2067.	2478.	2900.	588.77
7.00	1357.	1712.	2257.	588.46
7.25	877.	1117.	1655.	588.15
7.50	559.	718.	1156.	587.90
7.75	350.	455.	933.	587.69
8.00	217.	284.	734.	587.49
8.25	134.	175.	562.	587.32
8.50	82.	108.	423.	587.18
8.75	48.	65.	313.	587.07
9.00	26.	37.	228.	586.99
9.25	12.	19.	164.	586.92
9.50	4.	8.	137.	586.87
9.75	0.	2.	137.	586.82
10.00	0.	0.	137.	586.77

PEAK →

This routing established top of "settled" dam Elev. — Dam was actually constructed to elev. 593.0± to allow for expected foundation and dam fill consolidation (1.4'±) ←

VOLUME CHECK AT HP IS 0.58 PERCENT.
COMPUTED HP 4.67

APPENDIX 5

REFERENCES

FURNACE BROOK W.S. DAM 2

APPENDIX 5

REFERENCES

FURNACE BROOK W.S. DAM #2

1. Chow, Ven Te, Ph.D, Open Channel Hydraulics, McGraw-Hill Book Company, 1959.

2. Eby, C.F., 1976 Soil Survey of Morris County, New Jersey, U.S. Department of Agriculture, Soil Conservation Service, 111 pp.

3. United States Dept. of Agriculture, Soil Conservation Service SCS National Engineering Handbood Section 4 Hydrology NEH-Notice 4-102, August 1972.

4. United States Dept. of Agriculture, Soil Conservation Service, Somerset, N.J. Urban Hydrology for Small Watersheds, Technical Release No. 55, January 1975.

5. United States Dept. of Commerce Weather Bureau, April 1956 Hydrometeorological Report No. 33, Washington, D.C.

6. United States Dept. of Interior, Bureau of Reclamation Design of Small Dams, Second Edition 1973, Revised Print 1977.

7. Widmer, K., 1964, The Geology and Geography of New Jersey, Volume 19, The New Jersey Historical Series, D. Van Nostrand Co., Inc. Princeton, New Jersey, 193 pp.

8. Wolfe, P.E., 1977, The Geology and Landscapes of New Jersey, Crane, Russak & Company, Inc., New York, New York, 351 pp.

9. Design Report, U.S. Dept. of Agriculture, Soil Conservation Service, 6 pages, date unknown.

10. Soil Mechanics Laboratory Report, U.S. Department of Agriculture, Soil Conservation Service, dated 19 December 1969

11. Logs of Drill Holes and Test Pits,18 pages, date unknown.

12. Detailed Geologic Investigation of Furnace Brook Site, 11pages, United States Dept. of Agriculture, Soil Conservation Service, Somerset, N.J. dated unknown.

13. Operation and Maintenance Agreement for Structural Measures, U.S. Dept. of Agriculture, Soil Conservation Service, dated 30 October 1968.

DWG.	DWG. TITLE	BY	DATE
1.	Cover Sheet	U.S. Dept. of Agriculture Soil Conservation Service	As Built 1-72
2.	Dam Site & Pool Area	"	"
3.	Plan of Dam	"	"
4.	Profile of Dam	"	"
5.	Embankment & Aux. Spillway Details	"	"
6.	Cutoff Trench Details	"	"
7.	Drainage Details	"	"
8.	Principal Spillway	"	"
9.	Spillway & Structure Excavation	"	"
10.	Conduit Details	"	"
11.	Pond Drain Conduit Details	"	"
12. & 12A	Riser Structural Details	"	"
13	" "	"	"
14.	" "	"	"
15.	Riser Details	"	"
16.	Riser Accessories	"	"
17.	Impact Basin Details	"	"
18.	Reservoir Drain Inlet Details	"	"
19.	Relief Well Details	"	"
20.	Misc. Details	"	"
21.	Location Drill Hole & Test Pits	"	"